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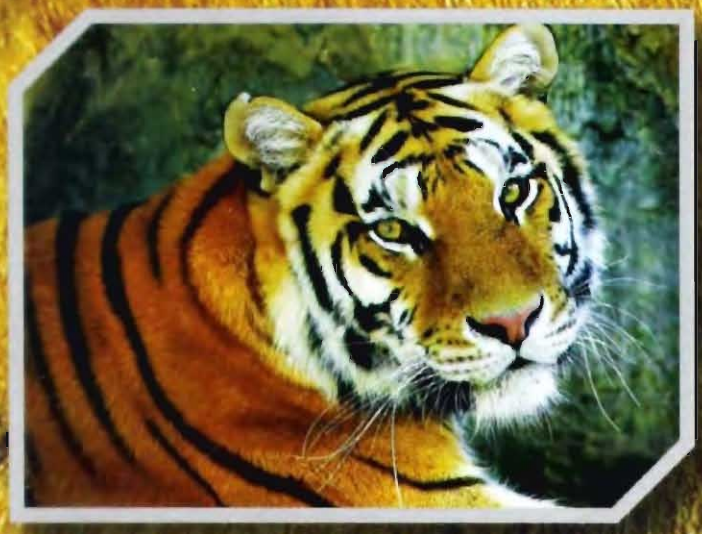

Atlas on Hairs of Indian Mammals

Part I : Carnivora

Rina Chakraborty
J.K. De

Zoological Survey of India

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PREFACE

Hairs of mammals are adorning part of the body and at the same time a pride of the mammalian species. It is not only held for recognition of the species but also for identifying the individuals. It is widely used in forensic study as an important tool for detecting crimes and identifying the seized items by the law of enforcement. Even then, it is surprising that no atlas on hairs of Indian mammals is available and hence the present communication.

It may be mentioned here that from the end of the 19th century till today mammalian species are the worst victims of anthropogenic activities which includes ruthless killing. Several laws have been introduced by the Government of India for the protection of endangered species. Though standard keys have been provided by several workers like Blanford (1888, 1891), Pocock (1939, 1941), Ellerman-Morrison Scott (1951), Corbet and Hill (1992) etc., yet identification of mammalian species from a small piece of skin or hair is still wanting. It has been realized that a complete key and atlas is necessary for identification of body parts of mammal species. Hence, this book is prepared for providing a complete key for identification of mammalian (Order : Carnivora) hair as well as parts of skin, to facilitate forensic investigation.

Among the mammalian fauna, most of the carnivore species are under threat, due to poaching, illegal trade, habitat destruction and many more anthropogenic activities. At the beginning of the last century in the year 1920, Hausman first initiated the work on trichotaxonomy. After that, many workers accelerated it from different parts of the world. But till now, no exhaustive and worthwhile contribution on trichotaxonomy of Indian carnivores has been made, probably because of the overlapping characters and non-availability of the hair samples. An attempt has been made in this book to provide a comprehensive account on both macro and micro structure of dorsal guard hairs of Indian carnivore species registered in National Zoological collection of Zoological Survey of India.

Hair structure of 54 species out of 60 Indian carnivores has been included in the present book and rest was not possible due to non-availability of material in the National Zoological collection of Zoological Survey of India.

The authors are thankful to Dr. Ramakrishna, Director, Zoological Survey of India for his constant guidance. We would like to thank Dr. A.K. Ghosh, Ex-Director, Zoological Survey of India, for initiating the work on mammalian trichotaxonomy in Zoological Survey of India during his tenure. We are also grateful to Dr. J.R.B. Alfred, former Director, Zoological Survey of India, for encouragement and also for providing research facility.

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Rina Chakraborty
J.K. De

CONTENTS

INTRODUCTION 1

GENERAL CHARACTERISTICS 1

Hair Profile 2

Hair Regions 2

Shape 2

Colour 2

Cuticle 3

A. Scale Position 3

B. Scale Type 3

C. Scale Pattern 3

D. Scale Margin 4

E. Scale Margin Distance 4

Medulla 4

A. Medullary Configuration 4

B. Medullary Margins 4

C. Medullary Index (k) 5

Cross-section 5

MATERIALS 5

METHODOLOGY 5

ABBREVIATIONS USED 5

KEY TO THE INDIAN SPECIES OF THE ORDER CARNIVORA 5

PLATE I-VI 12-17

Order CARNIVORA 19

I. Family FELIDAE 19

1. *Panthera tigris* (Linnaeus) 19
2. *Panthera leo* (Linnaeus) 21
3. *Panthera pardus* (Linnaeus) 23
4. *Uncia uncia* (Schreber) 25
5. *Acinonyx jubatus venaticus* (Griffith) 27
6. *Pardofelis marmorata* (Martin) 29
7. *Prionailurus rubiginosus* (I.Geoffroy Saint Hilaire) 31
8. *Prionailurus bengalensis* (Kerr) 33

9. *Prionailurus viverrinus* (Bennett) 35
10. *Otocolobus manul* (Pallas) 37
11. *Felis silvestris* Schreber 39
12. *Felis chaus* Schreber 41
13. *Catopuma temminckii* (Vigors & Horsfield) 43
14. *Caracal caracal* (Schreber) 45
15. *Lynx lynx* (Linnaeus) 47
16. *Neofelis nebulosa* (Griffith) 49

II. Family URSIDAE 51
17. *Ursus arctos* Linnaeus 51
18. *Ursus thibetanus* Cuvier 53
19. *Helarctos malayanus* (Raffles) 55
20. *Melursus ursinus* (Shaw) 57
21. *Ailurus fulgens* Cuvier 59

III. Family HYAENIDAE 61
22. *Hyaena hyaena* (Linnaeus) 61

IV. Family CANIDAE 63
23. *Canis aureus* Linnaeus 63
24. *Canis lupus* Linnaeus 65
25. *Vulpes vulpes* (Linnaeus) 67
26. *Vulpes bengalensis* (Shaw) 69
27. *Cuon alpinus* (Pallas) 71

V. Family HERPESTIDAE 73
28. *Herpestes edwardsi* (E.Geoffroy Saint-Hilaire) 73
29. *Herpestes javanicus* (E.Geoffroy Saint-Hilaire) 75
30. *Herpestes smithi* Gray 77
31. *Herpestes palustris* Ghose 79
32. *Herpestes urva* (Hodgson) 81

VI. Family VIVERRIDAE 83
33. *Viverricula indica* (Desmarest) 83
34. *Paguma larvata* (Hamilton-Smith) 85
35. *Prionodon pardicolor* Hodgson 87
36. *Arctictis binturong* (Raffles) 89
37. *Arctogalidia trivirgata* (Gray) 91
38. *Viverra zibetha* Linnaeus 93
39. *Viverra civettina* Blyth 95

40. *Paradoxurus jerdoni* Blanford 97
41. *Paradoxurus hermaphroditus* (Pallas) 99
VII. Family MUSTELIDAE 101
42. *Martes foina* (Erxleben) 101
43. *Martes flavigula* (Boddaert) 103
44. *Melogale personata* I.Geoffroy Saint Hilaire 105
45. *Melogale moschata* (Gray) 107
46. *Mellivora capensis* (Schreber) 109
47. *Mustela sibirica* Pallas 111
48. *Mustela erminea* Linnaeus 113
49. *Mustela kathia* Hodgson 115
50. *Mustela altaica* Pallas 117
51. *Lutra lutra* (Linnaeus) 119
52. *Lutrogale perspicillata* (I.Geoffroy Saint Hilaire) 121
53. *Arctonyx collaris* Cuvier 123
54. *Amblonyx cinereus* (Illiger) 125
Table – I 127
Table – II 134
Table – III 139
Summary 141
Bibliography 141

INTRODUCTION

From time immemorial mammal species devoted themselves to serve human being as food, pet, guard, game, amusement, ornament and so on. Their skins are being used as clothes, tents, shoes, carry bags, pots and fancies and for many other purposes. The hairs of mammals are used not only as fur but also in combination with natural or artificial fibers, for the production of cloth.

Tupinier (1973) stated that the study on mammalian hair was first started by Brewster in 1837 followed by Quekett in 1844. Later Hausman (1920) promoted studies on hair morphology and selected a variety of morphological features. Wildman (1954) also followed the nomenclature and methodology suggested by Hausman (1920). A number of scientists contributed to the knowledge of mammalian hair in their own ways. Identification of hair structure was utilized in food habit, identification of distributional range, environmental condition, forensic science, taxonomy and also in sex determination. The workers like Adorjan and Kolenosky (1969), Appleyard (1960), Appleyard and Greville (1950), Bahuguna and Mukherjee (2000), Benedict (1957), Brunner and Coman (1974), Cave (1969), Clement (1982), Cole (1924), Day (1966), de Boom and Dreyer (1953), Debrot *et al.* (1982), Dreyer (1966), Dziurdzik (1973), Fong and Inami (1988), Hausman (1920, 1924, 1930), Homan and Genoways (1978), Keller (1981, 1984), Khemelevskaya (1965), Kozhukovskaya (1969), Latham (1953), Lyne and McMohan (1951), Mathiak (1938), Mayer (1952), Miles (1965), Moore *et al.* (1974), Nason (1948), Noback (1951), Ogle and Mitosinka (1973), Perrin and Campbell (1979), Pocock (1914, 1939, 1941), Quekett (1844), Rosen (1974), Short (1978), Spence (1963), Stains (1958), Stoves (1944), Teerink (1991), Toth (2002), Tupinier (1973), Wallis (1993), Wildman (1961), Williams (1934, 1938), Williamson (1951) carried out exhaustive work in the field of trichotaxonomy of a number of mammal species from time to time.

Some work on the hairs of Indian mammal species was carried out by De (1993), Koppiker and Sabnis (1976, 1977) and Venkatraman *et al.* (1994). A detailed study on Indian carnivores was carried out by Chakraborty and De (1995, 2001, 2002, 2005), Chakraborty *et al.* (1996, 1999), De and Chakraborty (1995, 2002, 2006) and De *et al.* (1998). Nomenclature of hair was followed after Moore *et al.* (1974) and Teerink (1991). The colour shades were consulted from Ridgeway (1886). Coat colour, distribution and taxonomy of the species were followed after Alfred *et al.* (2002, 2006), Cheruvat *et al.* (2002) and Prater (1971).

So far, 60 species of the order Carnivora are reported from the Indian region under seven families *viz.* Canidae, Felidae, Herpestidae, Hyaenidae, Mustelidae, Ursidae and Viverridae of which 54 species have been included in this work. Only the mid-dorsal guard hairs have been selected for the present study. The samples were collected from the species registered in National Zoological collections of the Zoological Survey of India. The keys are prepared on the basis of both physical and microscopical characters upto species level. Though the keys are based on mid-dorsal guard hairs only, but it may be used for the guard hairs of the other regions also.

GENERAL CHARACTERISTICS

Hairs are characteristic feature of mammals. They may cover the entire body or may be reduced to patches or to scattered hairs. Hairs are cornified epidermal products of the integument. Collectively, the hairs covering the body of a

mammal species are known as pelage. They are periodically lost by moulting and replaced by a new ones.

Each hair originates from the bottom of a tubular invagination, or hair follicle of germinative layer of epidermis into dermis making an acute angle. A dermal or hair papilla, containing blood vessels and nerves, nourishes the swollen root or bulb, adding new cells forming the shaft of the hair. The cells of the shaft become keratinized, hard and soon die, so that the hair protruding above the skin is a dead structure. It is lubricated by the secretions of a sebaceous gland into follicle. A smooth *arrector pilli* muscle is associated with each follicle. Typically, the hair shaft consists of three layers : an external cuticle made up of overlapping microscopic scales, middle cortex containing shriveled cells and pigments, and inner medulla containing air spaces in larger hairs.

Chief functions of hairs seem to serve purpose of insulation of body and also as sensitive tactile organs like vibrissae. Hairs appear in various modified forms such as bristle, quill, spine, scale, horn *etc.* Colouration of hairs is useful for protective or aggressive functions in some cases. Sometimes males grow different types of hairs which give them distinct identifying character.

Hair Profile

The mammalian coat is composed of several types of hair of which the chief components are underhair and overhair or guard hair. The guard hair is long, stiff and also responsible for normal texture of the body (Plate I & II). It is usually divisible into several parts, the basal, subshield, shield and tip. Usually the shield is situated towards the distal part or towards the tip of the hair but the same may be much longer and may start from the proximal region also. Sometimes the hair is unshielded. The underhairs are thin, soft and usually undulating in appearance and have less taxonomic value. The guard hairs may be banded or non-banded and when banded the bands are usually noticed on the shield region.

Hair Regions

Different locations on a single hair are known as hair regions (Plate I, Fig. 1) and named as follows :

Basal : This area is thinner and contains the hair root or bulb. It usually comprises about the basal 1/5th of the shaft and is called as proximal end.

Sub-shield : The region in between the basal and shield is known as sub-shield.

Shield : The widest and rather flattened area of the shaft. If the widest area is not flattened the hair is considered as unshield. The banding pattern of the hair is usually predominant on the shield region.

Tip or Apical : The small pointed portion of the hair, situated just opposite to the root is called as tip or distal end.

Shape

The shape (Plate I) of hair is not uniform in case of all mammals and categorized as follows :

Spatulate : The hair is possessing round or semi-round basal region and, wide and flattened shield (Fig. 2).

Flattened : The hair is possessing flattened shield from the basal region and tapers towards the tip (Fig. 3).

Round or Oval : Unshield hair, round or oval throughout the shaft (Fig. 4).

Colour

The hairs may be unicoloured, bicoloured or banded (Plate I & II).

Unicolour : The hair is possessing uniform pigmentation throughout the shaft (Fig. 5).

Bicolour : The hair shaft is possessing light shade at the proximal end and dark shade at the distal end or reverse (Fig. 6).

Banded : The hair is possessing alternately arranged prominent light and dark bands (Fig. 7a-7d).

Cuticle

The outer most layer of the hair is known as cuticle which is made up of a large number of overlapping, transparent scales of keratin. The distal part of each scale lies over the proximal part of the next one. The size and shape of the scales vary according to the position of the hair. The scale pattern, scale position, scale margin and the distance between them are of various types and may vary from species to species or from family to family.

A. Scale Position

Scale position means arrangement of scales along the length of the hair. It may be transversal, longitudinal or intermediate (Plate III).

Transversal : The scales are arranged transversely along the length of the hair and scale margin distance is nearer than other two positional types. They lie at right angles to the longitudinal axis. Scale width is greater than scale length (Fig. 8).

Longitudinal : The scales are arranged longitudinally along the length and longitudinal axis of the hair and the length of the scale is greater than width (Fig. 9).

Intermediate : The intermediate type is actually intermediate in between the other two types where scale margin distance is neither lower than transversal type nor higher than longitudinal type and at the same time length and width of the scales are almost similar (Fig. 10).

B. Scale Type

The cuticular scales of mammals may be broadly categorized into two groups *viz.*, Imbricate and Coronal. The Imbricate scales are again divided into five sub groups such as Ovate, Acuminate, Elongate, Crenate and Flattened. The coronal scales are again classified into three sub groups such as Simple, Serrate and Dentate.

C. Scale Pattern

The cuticular scales are arranged in a definite pattern along the hair shaft and thus named as Scale Pattern (Plate III & IV). A single species usually carries a definite scale pattern and may sometimes be species or group specific also. But species belonging to different groups may carry same type of scale pattern. Sometimes a single hair shaft may bear different types of scale pattern which is called Transitional (Fig. 11). The main types of scale patterns found in carnivore are as follows :

Diamond Petal : The scale arrangement gives the appearance of diamond pattern with petaloid form and oriented along the longitudinal axis of the hair. Normally the tip of the lower scale touches the trough of the upper scale (Fig. 12).

Irregular Mosaic : The scales are different in shape and size and practically have no definite arrangement style. The style appears in a design of mosaic from (Fig. 13).

Irregular Petal : Overlapping scales, almost similar to flower petals which are not uniform in shape and size (Fig. 14).

Irregular Wave : Usually continuous and wavy in appearance but waves are unequal and not placed along the equal axis. At the same time crests of the waves differ much from one another (Fig. 15).

Irregular Waved Mosaic : A combination of waved and mosaic pattern. The waves formed by the margins are not continuous as well as uniform in size and shape (Fig. 16).

Pectinate : A series of combing arrangement of elongated scales which are often placed obliquely to the longitudinal axis of the hair shaft. Crests of the waves of one row alternatively arranged with troughs of the row above it (Fig. 17).

Regular Mosaic : Uniformly arranged scales of almost equal size and shape (Fig. 18).

Regular Petal : Scales similar to flower petals of uniform size and shape and arranged along the longitudinal axis of the hair shaft (Fig. 19).

Regular Wave : Smooth, wavy arrangement of a single scale with uniform scale mounds (Fig. 20).

D. Scale Margin

The outer edge of the scale is known as scale margin which has got a distinct pattern (Plate IV).

Smooth : The outer edge of the scale is without any indentations and looks smooth (Fig. 21).

Crenate : The outer edge of the scale is having a saw tooth appearance with little indentations (Fig. 22).

Rippled : Almost like crenate but with deeper indentations (Fig. 23).

E. Scale Margin Distance

The distance between the two successive scale margins may vary and are usually of three types as follows (Plate IV) :

Close : The margins of the successive scales are quite near or close to each other (Fig. 24).

Distant : The margins of the two successive scales lie far away from each other (Fig. 25).

Near or Intermediate : The margins of the two successive scales are neither too close nor too far (Fig. 26).

Medulla

The central core of most of the guard hair medulla is composed of discrete cells or an amorphous spongy mass. The cells along with intercellular air spaces give a specific structure or pattern. The medulla may be continuous or fragmented and rarely, the hairs may be amedullated also.

A. Medullary Configuration

The medulla structure or pattern is known as medullary configuration (Plate V).

Amedullated : No medulla is present throughout the hair length (Fig. 27).

Fragmented : The medulla is not continuous and interrupted by cortical intrusion (Fig. 28).

Uniserial ladder : A continuous single coloumn of cells interrupted with cortical matter and looks like a septa (Fig. 29).

Multiserial ladder : Rows of coloumn of rectangular cells (Fig. 30).

Unbroken amorphous : Spongy material with no distinct cellular structure (Fig. 31).

Unbroken cellular : A continuous tubular structure, made up of distinct irregular cells (Fig. 32).

Unbroken vacuolated : A continuous tubular structure with distinct cells of which some appears as large vacuoles (Fig. 33).

Unbroken with cortical intrusions : A tubular structure with intrusion of cortical material along the side line (Fig. 34).

Unbroken lattice : The medullar cells usually fill the entire width of the hair and cortex layer is very thin or hardly distinguished (Fig. 35).

Interrupted : The medulla is discontinuous or fragmented throughout the hair length (Fig. 36).

B. Medullary Margins

Medulla margins are usually of three types (Plate V).

Straight : Medulla margin is simple and straight throughout its length (Fig. 37).

Fringed : Intrusion of cortical material in the medullar portion which gives a thin comb like structure (Fig. 38).

Scalloped : Series of convex projection of medulla into the cortex along with its length (Fig. 39).

C. *Medullary Index (k)*

Medullary index is the ratio of medulla and cortex of a hair. It is almost constant in a single species or may be said as species specific. It is calculated as follows: $k = m/c$ where m = width of medulla and c = width of hair.

Cross-section

The circumference of hair shows considerable variation. It is usually circular, oval, oblong, concavo-convex or reniform, biconvex, biconcave in shape (Plate VI, Figs. 40-45). Some rare forms like triconcave, quadriconcave, dumb-bell, curved *etc.* are also available.

MATERIALS

It is advisable to collect hairs from the mid-dorsal region of the body and the same are to be treated with carbon-tetrachloride or acetone for removing the fat bodies and other depositions on the hair samples.

METHODOLOGY

Study of the Physical Characters

To study the physical characters, like colour, banding pattern, shape, nature *etc.* a single hair is to be put parallel to the length of a clean glass slide either on the both sided adhesive tape or to be mounted temporarily with glycerine. To prepare a permanent slide, the whole hair is to be mounted in Canada Balsum. Examination of whole hair may be carried out with powerful binocular. The diameter and length of hair are to be measured with dial calipers and measuring scales (mm) respectively.

Study of the Microscopic Characters

For studying the microscopic characters the samples are to be washed in different grades of aqua-acetone solution, starting with 50 percent and gradually raising up to pure acetone through the grades of 70, 80, 90 and 95 percent. Washing time in each grade are 30 minutes and the samples are finally kept in pure acetone for overnight. For getting casts of cuticular scales, thin film of clear varnish is to be drawn on the microscopic glass slide. The acetone treated dry hair is to be put on the film with a little pressure by a fine needle. Then the film is dried for 8-10 hours. Before examining under microscope the hair sample is pulled off gently with fine forceps leaving the casts of scales on the varnish. The slides are kept in air tight cabinet to prevent dust accumulation.

For the study of medulla, hairs are to be cut into pieces. Basal, middle and apical pieces are to be treated separately with Carbon Tetrachloride for four hours to allow infiltration of the fluid in the medullar region and then mounted on glass slides with Canada Balsam-Xylol solution (70 : 30). Medulla configuration, cuticular scale structure along with their number, shape and dimensions are to be studied under 250X, 400X and 1000X magnification.

ABBREVIATIONS USED

A : Apical; B : Basal; M : Middle; S : Shield; Ssh : Subshield; SS : Side to side cuticular scale length; PD : Proximodistal scale length.

KEY TO THE INDIAN SPECIES OF THE ORDER CARNIVORA

1. Scale type Imbricate; cross section mostly circular, ovate, oblong or reniform.....Order Carnivora

Genus *Panthera*

1a. Hairs entirely black or brown, without black tip; scale pattern 'irregular waved mosaic'; scale margin irregularly waved with notches with 'intermediate' distance; medullary configuration 'unbroken vacuolated'; medullary index 0.663 ± 0.004; cross section circular.....*P. pardus*

1b. Medullary configuration 'simple unbroken amorphous'; medullary index <0.60.....2

2a. Hairs reddish yellow to orange rufous, with or without black tip or entirely black; scale pattern 'irregular wave'; scale margin 'crenate'; scale margin distance 'intermediate'; medullary index 0.551 ± 0.006; cross section 'circular' ....*P. tigris*

2b. Hairs pale buff to yellow, with or without black tip or entirely black; scale pattern 'irregular waved-mosaic'; scale margin mostly smooth with little waves; scale margin distance 'intermediate'; medullary index 0.553 ± 0.002; cross section 'circular' .....*P. leo*

Genus *Uncia*

Basal almost white or pale buff, rest of hair light brown with or without dark tip; scale pattern 'irregular wave' scale margin 'irregularly rippled'; scale margin distance 'distant', medulla 'unbroken vacuolated', 'medullary index' 0.665 ± 0.005; cross section 'circular'.....*U. uncia*

Genus *Acinonyx*

Hair light brown to dark tawny but usually buff at basal, tawny at middle, brown at tip; shaft thin, straight, rod like; scale pattern 'irregular wave'; scale margin 'irregularly rippled'; scale margin distance 'intermediate'; medullary configuration 'simple unbroken amorphous'; medullary index 0.635 ± 0.001; cross section 'circular'.....*A. jubatus*

Genus *Felis*

1a. Hair dark buff or light yellow with creamy buff band at apical; scale pattern 'regular mosaic'; scale margin 'smooth'; scale margin distance 'distant'; medullary configuration 'uniserial ladder'; medullary index 0.755 ± 0.00025; cross section 'circular'. .....*F. silvestris*

1b. Hairs almost rod like with 3 or 4 constrictions; alternately banded with Prout's brown and olive or cream buff, tip dark and basal lighter; scale pattern 'irregular wave' at basal and 'mosaic' at shield and subshield; scale margin 'crenate' at basal and 'smooth' at shield and subshield; scale margin distance 'intermediate'; medullary configuration 'unbroken vacuolated'; medullary index 0.699 ± 0.004; cross section 'ovate'..... .....*F. chaus*

Genus *Pardofelis*

Colour seal brown with or without a white or cream band below the tip; scale pattern 'regular wave' at basal and sub-shield and 'diamond petal' or 'broad petal' at shield; scale margin 'smooth', scale margin distance 'intermediate' at basal and subshield and 'distant' at shield; medullary configuration 'uniserial ladder'; medullary index 0.577 ± 0.004; cross section almost 'circular' .....*P. marmorata*

Genus *Neofelis*

Colour chocolate brown; scale pattern 'irregular wave' at basal and sub-shield, and 'mosaic' at shield; scale margin 'crenate' at basal and sub-shield and 'smooth' at shield; scale margin distance 'intermediate' at basal and sub-shield and 'distant' at shield; medullary configuration 'unbroken vacuolated'; medullary index 0.62 ± 0.008; cross section 'ovate' ....*N. nebulosa*

Genus *Catopuma*

Upper shaft brunt umber, lower tawny; scale pattern 'regular mosaic'; scale margin 'smooth'; scale margin distance 'intermediate'; medullary configuration 'unbroken cellular'; medullary index 0.595 ± 0.0026; cross section almost 'circular' .....*C. temminckii*

Genus *Prionailurus*

1a. Colour seal brown with lighter basal, may be with a light band below the tip; scale margin 'rippled' at basal and sub-shield, 'smooth' at shield; scale margin distance 'close' at basal, 'intermediate' at subshield and 'distant' at shield; scale pattern 'irregular wave' at basal and subshield and 'mosaic' at shield; medullary configuration 'unbroken cellular' medullary index 0.778 ± 0.001; cross section 'ovate' .....*P. rubiginosus*

1b. Scale margin 'crenate'; scale margin distance 'close'; scale pattern 'irregular wave'; cross section

ovate; medullary configuration 'unbroken cellular' 2

2a. Colour dark chestnut brown with lighter basal region or dark chestnut with light tawny band below the tip or tawny with dark chestnut tip; medullary index 0.79 ± 0.07 .....*P. bengalensis*

2b. Colour dark chestnut brown with lighter basal region or dark chestnut with light tawny band below the tip or tawny with dark chestnut tip; medullary index 0.75 ± 0.009.....*P. viverrinus*

Genus *Lynx*

Hairs almost rod like; number of bands five, alternately banded with dark seal brown and cream buff; scale pattern 'regular wave'; scale margin 'smooth'; scale margin distance 'intermediate'; medullary configuration 'unbroken cellular'; medullary index 0.806 ± 0.0304; cross section 'ovate'.....*L. lynx*

Genus *Otocolobus*

Colour chestnut brown or dark bay with a broad white apical band at the widest portion; scale pattern 'regular mosaic'; scale margin 'smooth'; scale margin distance 'intermediate'; medullary configuration 'unbroken amorphous'; medullary index 0.62 ± 0.006; cross section 'oblong' .....*O. manul*

Genus *Caracal*

Colour dark chocolate brown, basal russet; scale pattern 'irregular waved mosaic'; scale margin 'crenate'; scale margin distance 'close'; medullary configuration 'unbroken amorphous'; medullary index 0.805 ± 0.001; cross section 'ovate'.....*C. caracal*

Family URSIDAE

1a. Medullary configuration 'unbroken vacuolated/ unbroken cellular'; medullary index <0.50.....2

1b. Medullary configuration 'simple unbroken amorphous'; medullary index >0.50.....3

2. Hairs shielded; scale pattern 'irregular wave' at basal and subshield and 'irregular mosaic' at shield region.....Genus *Ursus*

2a. Colour seal to clove brown; scale margin 'smooth'; scale margin distance 'intermediate'; medullary configuration 'unbroken cellular'; cross section 'oval'; medullary index 0.33 ± 0.012 ...*U. arctos*

2b. Colour black; scale margin 'crenate'; scale margin distance 'close'; cross section 'circular'; medullary index 0.31 ± 0.01.....*U. thibetanus*

3a. Medullary configuration 'simple unbroken amorphous', medullary index >0.80.....4

3b. Medullary configuration 'unbroken cellular', medullary index <0.80 5

Genus *Melursus*

4a. Colour black; scale margin 'smooth'; scale margin distance 'intermediate'; scale pattern 'irregular wave' at basal and subshield with 'irregular mosaic' at shield; medullary configuration 'simple unbroken amorphous'; cross section 'oblong'; medullary index 0.91 ± 0.008 .....*M. ursinus*

Genus *Helarctos*

4b. Colour black; almost curly; scale margin 'crenate'; scale margin distance 'intermediate'; scale pattern 'regular wave' at subshield and shield with 'irregular mosaic' at basal; cross section 'circular'; medullary index 0.87 ± 0.001 .....*H. malayanus*

Genus *Ailurus*

5. Colour of basal region cinnamon or fawn, distal brunt umber; scale pattern 'diamond petal'; scale margin 'smooth'; scale margin distance 'distant'; medullary configuration 'unbroken cellular'; medullary index 0.63 ± 0.011; cross section 'circular'.....*A. fulgens*

Family HYAENIDAE

Genus *Hyaena*

Hair colour sil brown at tip, paler towards root, cream-buff at base; number of bands 2-3; scale pattern 'irregular wave'; scale margin distance 'intermediate'; scale margin 'crenate'; medullary configuration 'simple unbroken cellular'; medullary index 0.57 ± 0.002; cross section almost circular.....*H. hyaena*

Family CANIDAE

1a. Medullary configuration 'vacuolated'; cross section 'circular'; medullary index > 0.70.....2

1b. Medullary configuration 'vacuolated'; cross section 'circular'; medullary index <0.70.....3

Genus *Vulpes*

2a. Colour brunt umber or Prout's brown with or without broad cream buff or lighter band at shield, base white or paler; scale margin 'crenate' at basal and middle, 'smooth' at apical; scale margin distance 'intermediate' at basal and middle, apical 'distant'; scale pattern 'irregular wave' at basal, 'irregular mosaic' at middle and pectinate or mosaic at apical; medullary index 0.722 ± 0.004 .....*V. vulpes*

2b. Colour brunt umber, paler to white from subshield to basal region; single white band at shield region; scale margin almost 'smooth' with few notches; scale margin distance 'distant' at apical, 'intermediate' at basal and middle; scale pattern 'irregular waved mosaic' at basal and middle, apical 'diamond petal'; medullary index 0.81 ± 0.012.....*V. bengalensis*

Genus *Canis*

3a. Brunt umber usually with broad white or fawn coloured band at subshield, rarely posterior, basal region lighter; scale margin distance 'intermediate'; scale pattern 'irregular wave' scale margin 'crenate'; medullary index 0.67 ± 0.02 .....*C. aureus*

3b. Colour in extreme basal, white, basal brunt umber, middle cream buff, apical clove brown; scale margin distance 'intermediate'; scale pattern 'irregular wave'; scale margin 'smooth with number of notches'; medullary index 0.55 ± 0.018 ....*C. lupus*

Genus *Cuon*

Colour brunt umber with a very broad fawn coloured band just below the tip, basal sometimes whitish; hair rod like; unshield; scale margin distance 'intermediate' at basal and middle, apical 'distant'; scale pattern 'irregular wave' at basal and middle, apical 'pectinate'; scale margin at basal and middle 'crenate', apical 'smooth'; medullary index 0.59 ± 0.02..... .....*C. alpinus*

Family HERPESTIDAE

Genus *Herpestes*

1a. Medullary configuration 'unbroken with cortical intrusion' 2

1b. Medullary configuration not of the above type3

2a. Hair alternately banded with clove brown and buff with dark tip; scale margin 'smooth'; scale pattern 'flattened irregular mosaic'; scale margin distance 'near'; medullary index 0.885 ± 0.0067; cross section 'ovate' .....*H. javanicus*

2b. Hair alternately banded with cream buff and clove brown, tip dark; sometimes overall ferrugineous; scale margin 'crenate'; scale margin distance 'near'; scale pattern 'irregular wave'; medullary index 0.82 ± 0.003; cross section 'oblong' .....*H. edwardsi*

3a. Hair alternately banded with ochraceous buff and Prout's brown, tip dark; scale margin 'smooth with few notches'; scale margin distance near; scale pattern 'irregular wave'; medullary configuration 'narrow aeriform lattice'; medullary index 0.755 ± 0.004; cross section 'ovate'..... .....*H. palustris*

3b. Medullary index less than 0.62; scale margin 'crenate'; 4

4a. Hair alternately banded with cream and clove brown, tip dark; scale pattern 'irregular wave'; medullary configuration 'unbroken cellular'; medullary index 0.617 ± 0.008; cross section 'ovate'.....*H. smithi*

4b. Hair alternately banded with pale cinnamon and dusky iron grey, tip dark; scale pattern irregular wave; medullary configuration 'unbroken vacuolated'; medullary index 0.506 ± 0.01..... .....*H. urva*

Family VIVERRIDAE

Genus *Arctictis*

Colour black; hair rod like; scale pattern 'irregular wave'; scale margin distance 'intermediate'; scale margin 'crenate'; medullary configuration 'simple'; cross section 'reniform'; medullary index 0.93 ± 0.001 .....*A. binturong*

Genus *Paguma*

Claret brown with lighter basal, dark apical and single broad buff band at subshield; scale pattern 'irregular wave'; scale margin 'crenate'; scale margin distance 'close'; medullary configuration 'unbroken vacuolated'; cross section 'ovate'; medullary index 0.826 ± 0.01 .....*P. larvata*

Genus *Viverra*

1a. Colour claret brown, 1 narrow buff band, if present not more than 4 mm at sub shield; scale pattern 'transitional'; 'regular mosaic' at shield 'regular wave' at basal and subshield; scale margin 'smooth'; scale margin distance 'distant' at shield and 'intermediate' at basal and subshield; medullary configuration 'unbroken vacuolated'; cross section 'ovate'; medullary index 0.89 ± 0.01 .....*V. zibetha*

1b. Colour dark bay; band 1 or absent, if present more than 4 mm in width; scale pattern 'irregular wave'; scale margin distance 'intermediate'; scale margin 'crenate'; medullary configuration 'unbroken vacuolated'; cross section 'ovate'; medullary index 0.62 ± 0.09.....*V. civettina*

Genus *Viverricula*

Colour claret brown with buff band at shield; scale pattern 'transitional'; 'regular petal' at shield, 'irregular wave' at basal and subshield; scale margin 'crenate' at basal and subshield, and 'smooth' at shield; scale margin distance 'distant' at shield and 'close' at basal and subshield; medullary configuration 'unbroken vacuolated'; cross section 'ovate'; medullary index 0.769 ± 0.02.....*V. indica*

Genus *Prionodon*

Colour claret brown, broad buff band at subshield, if present; scale pattern 'transisional'; 'narrow diamond petal' at shield; 'regular wave' at basal and subshield; scale margin smooth; scale margin distance 'distant' at shield and 'intermediate' at basal and subshield; medullary configuration 'unbroken vacuolated'; cross section 'circular'; Medullary index 0.64 ± 0.08 .....*P. pardicolor*

Genus *Arctogalidia*

Colour burnt sienna, lighter at basal; scale pattern 'irregular wave'; scale margin 'crenate'; scale margin distance 'intermediate'; medullary configuration 'unbroken vacuolated'; cross section 'circular'; medullary index 0.66 ± 0.02 .....*A. trivirgata*

Genus *Paradoxurus*

1a. Dark bay, either in whole or at apical, basal lighter; scale pattern 'irregular wave'; scale margin distance 'close'; scale margin 'crenate'; medullary configuration 'unbroken vacuolated'; cross section 'ovate'; medullary index 0.72 ± 0.02 ....*P. hermaphroditus*

1b. Claret brown, lighter at basal; scale pattern 'irregular wave'; scale margin 'crenate'; scale margin distance 'intermediate'; medullary configuration 'unbroken vacuolated'; cross section 'circular'; medullary index 0.64 ± 0.03 .....*P. jerdoni*

Family MUSTELIDAE

Genus *Martes*

1a. Colour vandyke brown with lighter basal; scale margin 'crenate'; scale pattern 'irregular wave'; scale margin distance 'intermediate'; medullary configuration 'narrow medulla lattice'; medullary index 0.79 ± 0.011 ; cross section 'oblong' .....*M. foina*

1b. Colour brunt umber with lighter basal; scale margin 'crenate'; scale pattern 'irregular wave';

scale margin distance 'intermediate'; medullary configuration 'narrow medulla lattice'; medullary index 0.70 ± 0.01; cross section 'oblong' .....*M. flavigula*

Genus *Melogale*

1a. Colour clove brown from shield to upper part and basal drab; scale margin 'crenate'; scale pattern 'irregular wave'; scale margin distance 'intermediate'; medullary configuration 'unbroken lattice'; medullary index 0.75 ± 0.02; cross section 'oblong' .....*M. personata*

1b. Colour vandyke brown with paler basal; scale margin 'crenate'; scale pattern 'irregular wave'; scale margin distance 'intermediate'; medullary configuration 'unbroken lattice'; medullary index 0.75 ± 0.013; cross section 'oblong'. .....*M. moschata*

Genus *Mellivora*

Colour from shield to tip slaty grey with lighter basal; scale margin 'crenate'; scale pattern 'irregular wave'; scale margin distance 'intermediate'; medullary configuration 'unbroken amorphous'; medullary index 0.59 ± 0.04; cross section 'reniform'/'concavo-convex' .....*M. capensis*

Genus *Mustela*

1a. Colour from shield to tip brunt umber with lighter basal; scale margin 'smooth'; scale pattern 'regular wave' at basal and subshield and at shield 'diamond petal'; scale margin distance 'intermediate' at basal and subshield, 'distant' at shield; medullary configuration 'unbroken amorphous'; medullary index 0.61 ± 0.01; cross section 'oblong' .....*M. sibirica*

1b. Colour mummy brown; scale margin 'crenate' at basal and subshield and 'smooth' at shield; scale pattern 'irregular wave' at basal and subshield and 'diamond petal' at shield; scale margin distance 'intermediate' at basal and subshield, 'distant' at shield; medullary configuration 'unbroken cellular'; medullary index 0.50 ± 0.017; cross section 'oblong or oval' .....*M. erminea*

1c. Colour brown; scale margin 'smooth'; scale pattern 'diamond petal'; scale margin distance 'distant'; medullary configuration 'narrow aeriform lattice'; medullary index 0.65 ± 0.007; cross section 'oblong' .....*M. kathiah*

1d. Colour bistre; scale margin 'smooth'; scale pattern 'irregular wave'; scale margin distance 'distant'; medullary configuration 'diamond petal'; medullary index 0.52 ± 0.06; cross section 'oval' .....*M. altaica*

Genus *Lutra*

Colour at shield and upper part Prout's brown with lighter basal; scale margin at basal and subshield 'rippled' and 'smooth' at shield; scale pattern 'irregular wave' at basal and subshield and 'diamond petal' at shield; scale margin distance 'near' at basal, 'intermediate', at subshield and 'distant' at shield; medullary configuration 'unbroken cellular'; medullary index 0.64 ± 0.002; cross section 'circular' .....*L. lutra*

Genus *Lutrogale*

Colour from shield to tip Prout's brown with lighter basal; scale margin 'crenate' at basal and subshield and 'smooth' at shield; scale pattern 'irregular wave' at basal and subshield and 'diamond petal' at shield; scale margin distance 'intermediate' at basal and subshield and 'distant' at shield; medullary configuration 'unbroken cellular'; medullary index 0.62 ± 0.003; cross section 'oblong'..... .....*L. perspicillata*

Genus *Arctonyx*

Colour from shield to upper part clove brown and rest yellow ochre; scale margin 'crenate'; scale pattern 'irregular wave'; scale margin distance 'intermediate'; medullary configuration 'unbroken amorphous';

medullary index 0.50 ± 0.002; cross section 'oval to oblong' .....***A. collaris***

Genus ***Amblonyx***

Colour from shield to tip burnt umber with lighter basal; scale margin 'crenate' at basal, 'smooth' at shield and subshield; scale pattern 'irregular wave' at basal, 'diamond petal' at shield and subshield; scale margin distance 'intermediate' at basal, 'distant' at shield and subshield; medullary configuration 'unbroken cellular'; medullary index 0.72 ± 0.007; cross section 'oval or oblong'.....***A. cinereus***

The hair characteristics are so much overlapping that it is simply impossible to identify a species or family with one or two characters but the same could be identified with the help of a group of characters. Among the 60 Indian carnivore species, hair characteristics of 54 species belonging to 7 families and 36 genera are provided in this book.

Plate – I

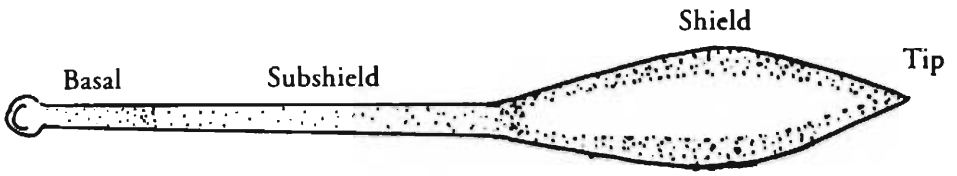


Fig. 1 : Hair Regions

SHAPE

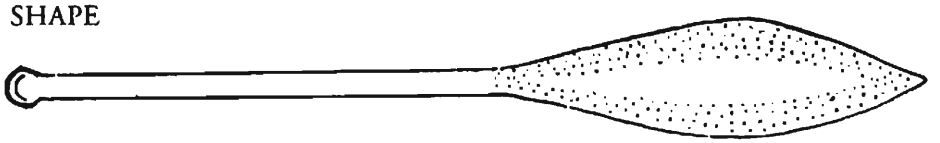


Fig. 2 : Spatulate

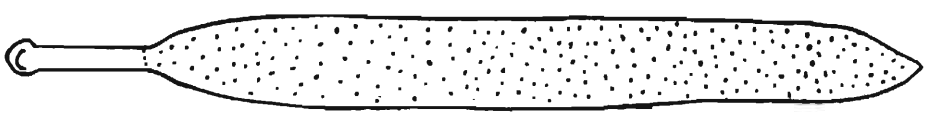


Fig. 3 : Flattened

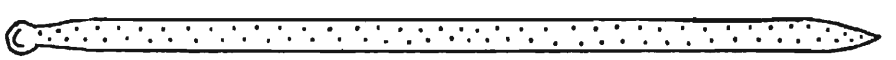


Fig. 4 : Round or oval

COLOUR

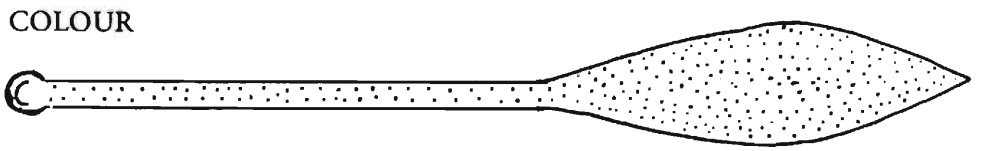


Fig. 5 : Unicolour

Fig. 6 : Bicolour

Plate – II

BANDED HAIRS

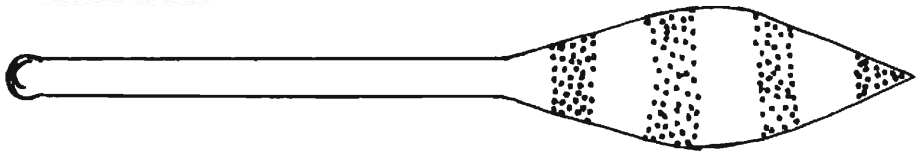


Fig. 7a : Alternate bands at shield

Fig. 7b : Single band at shield

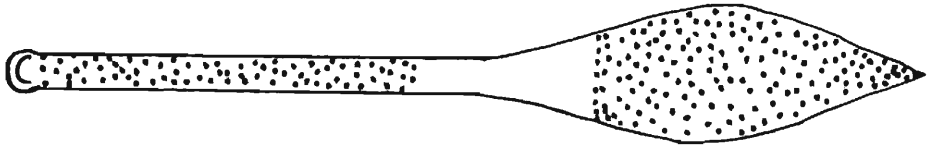


Fig. 7c : Single band started from sub-shield

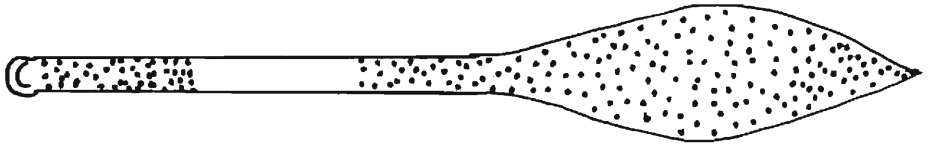


Fig. 7d : Single band near basal

Plate – III

A. SCALE POSITION

Fig. 8 : Transversal

Fig. 9 : Longitudinal

Fig. 10 : Intermediate

B. SCALE PATTERN

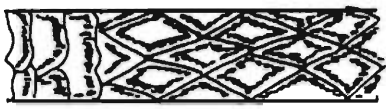


Fig. 11 : Transitional

Fig. 12 : Diamond Petal

Fig. 13 : Irregular Mosaic

Fig. 14 : Irregular Petal

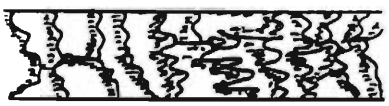


Fig. 15 : Irregular Wave

Plate – IV

SCALE PATTERN (contd.)

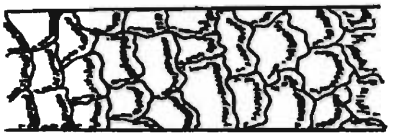


Fig. 16 : Irregular waved Mosaic

Fig. 17 : Pectinate

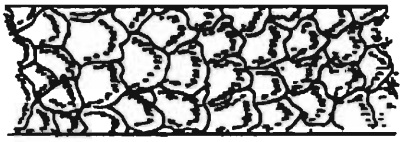


Fig. 18 : Regular Mosaic

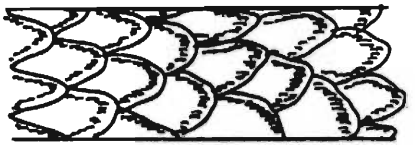


Fig. 19 : Regular Petal

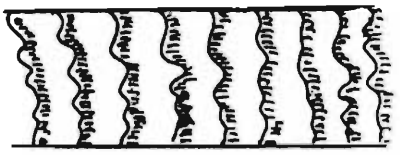


Fig. 20 : Regular Wave

C. SCALE MARGIN

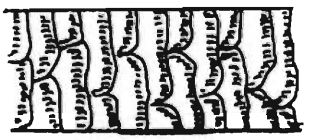


Fig. 21 : Smooth

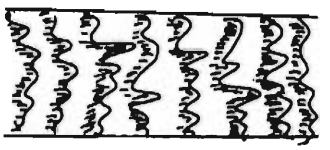


Fig. 22 : Crenate

Fig. 23 : Rippled

D. SCALE MARGIN DISTANCE

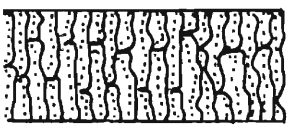


Fig. 24 : Close

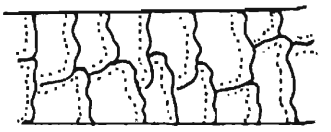


Fig. 25 : Distant

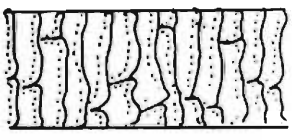


Fig. 26 : Near or Intermediate

Plate – V

E. MEDULLARY CONFIGURATION

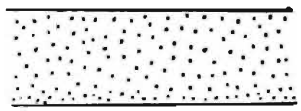


Fig. 27 : Amedullated

Fig. 28 : Fragmented

Fig. 29 : Uniserial Ladder

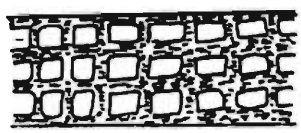


Fig. 30 : Multiserial Ladder

Fig. 31 : Unbroken Amorphous

Fig. 32 : Unbroken Cellular

Fig. 33 : Unbroken Vacuolated

Fig. 34 : Unbroken with cortical intrusions

Fig. 35 : Unbroken Lattice

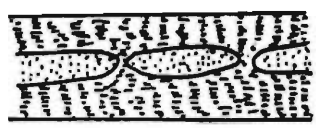


Fig. 36 : Interrupted

F. MARGINS OF MEDULLA

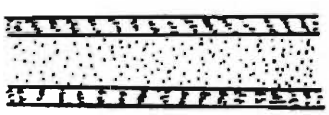


Fig. 37 : Straight

Fig. 38 : Fringed

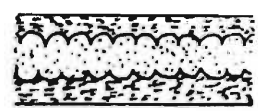


Fig. 39 : Scalloped

Plate – VI

CROSS SECTION

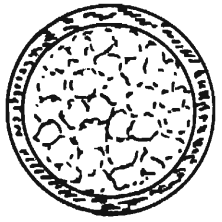


Fig. 40 : Circular

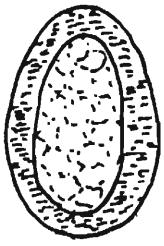


Fig. 41 : Oval or Ovate

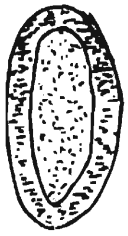


Fig. 42 : Oblong

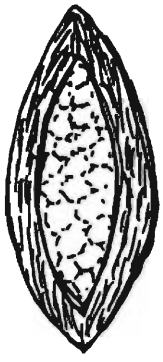


Fig. 43 : Biconvex

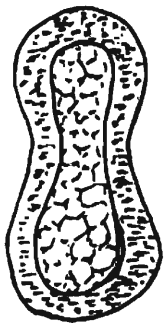


Fig. 44 : Biconcave

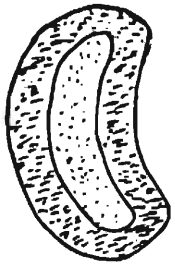


Fig. 45 : Concavo-convex or Reniform

1. *Panthera tigris* (Linnaeus)

Order **CARNIVORA**

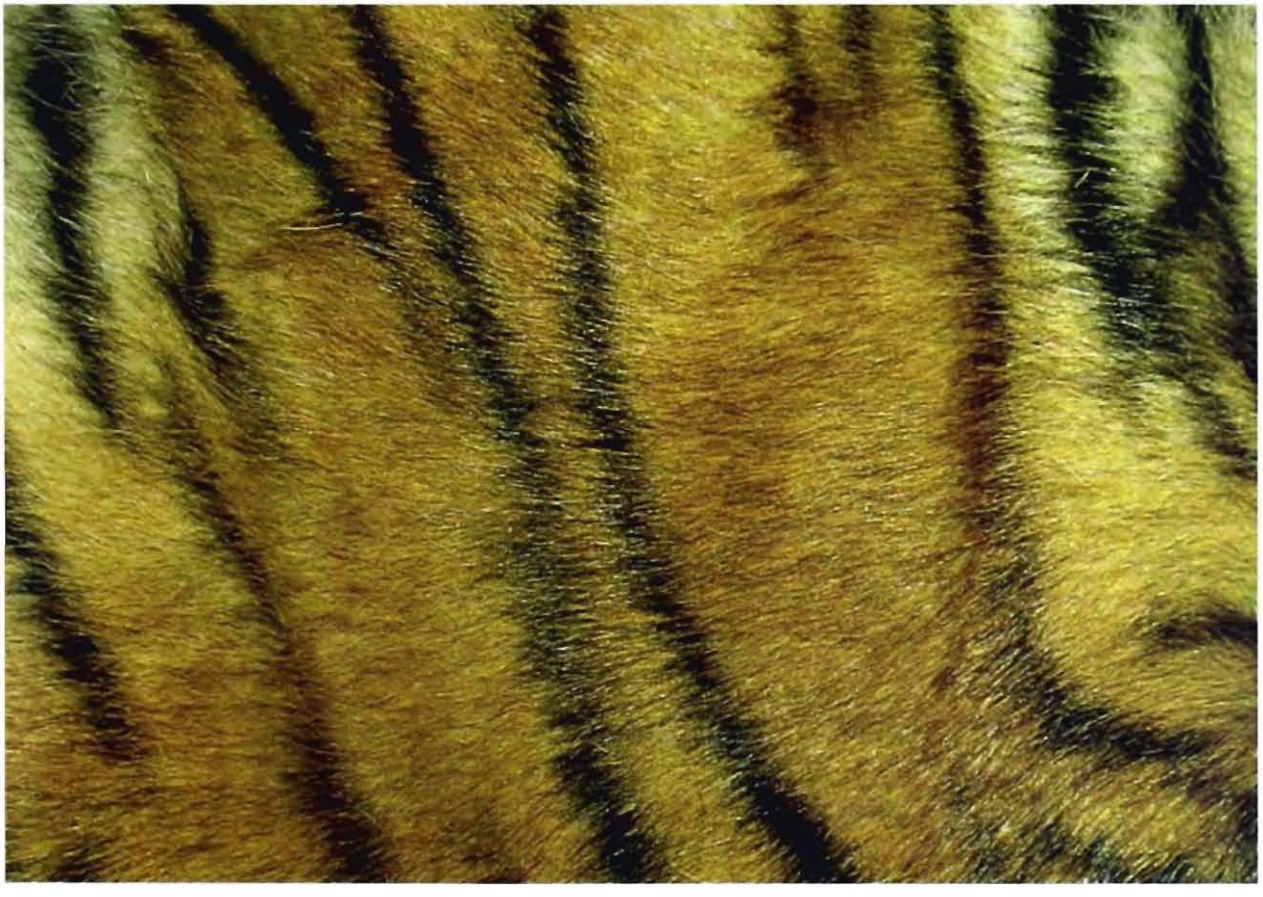
I. Family **FELIDAE**

Common name : Tiger

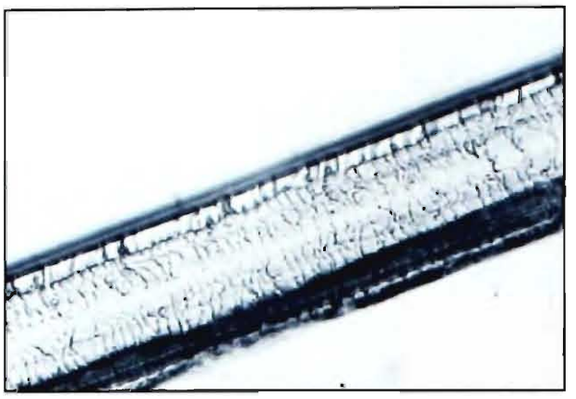
Coat colour : Coat orange rufous with black stripes.

Distribution : Throughout India in suitable pockets except desert region. *Extralimital* : Bangladesh, Bhutan, China, Laos, Indonesia, Korea, Malaysia, Myanmar, Nepal, Thailand, Vietnam, CIS countries.

Characteristics of hair : *Colour* : Unicoloured or bicoloured, reddish yellow to orange rufous, with or without black tip or entirely black; *Profile* : Straight, shielded and spatulate; *Length* : 12-37 mm (31.8 ± 6); *Diameter* : Basal : 30-40 µ (36 ± 3), Sub-shield : 30-50 µ (40 ± 5), Shield : 50-60 µ (56 ± 1); *Scale type* : Imbricate-flattned; *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : Basal : 280-330 (300), Shield & Sub-shield : 150-200 (180); *SS* : 12-30 µ (18 ± 6); *PD* : 4-9 µ (7 ± 2); *Medullary configuration* : Simple unbroken amorphous; *Medullary index* : 0.541-0.563 (0.551 ± 0.006). *Cross Section* : Circular.



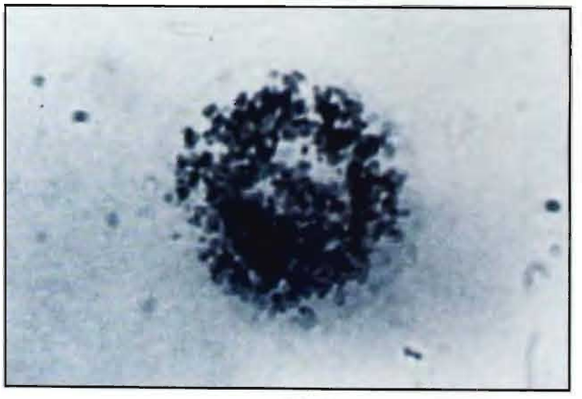
Pelage colour of Tiger



Cuticle (Basal)

Cuticle (Shield & Sub-shield)

Medulla



Cross Section

Microstructure of dorsal guard hair of Tiger, *Panthera tigris* (Linnaeus)

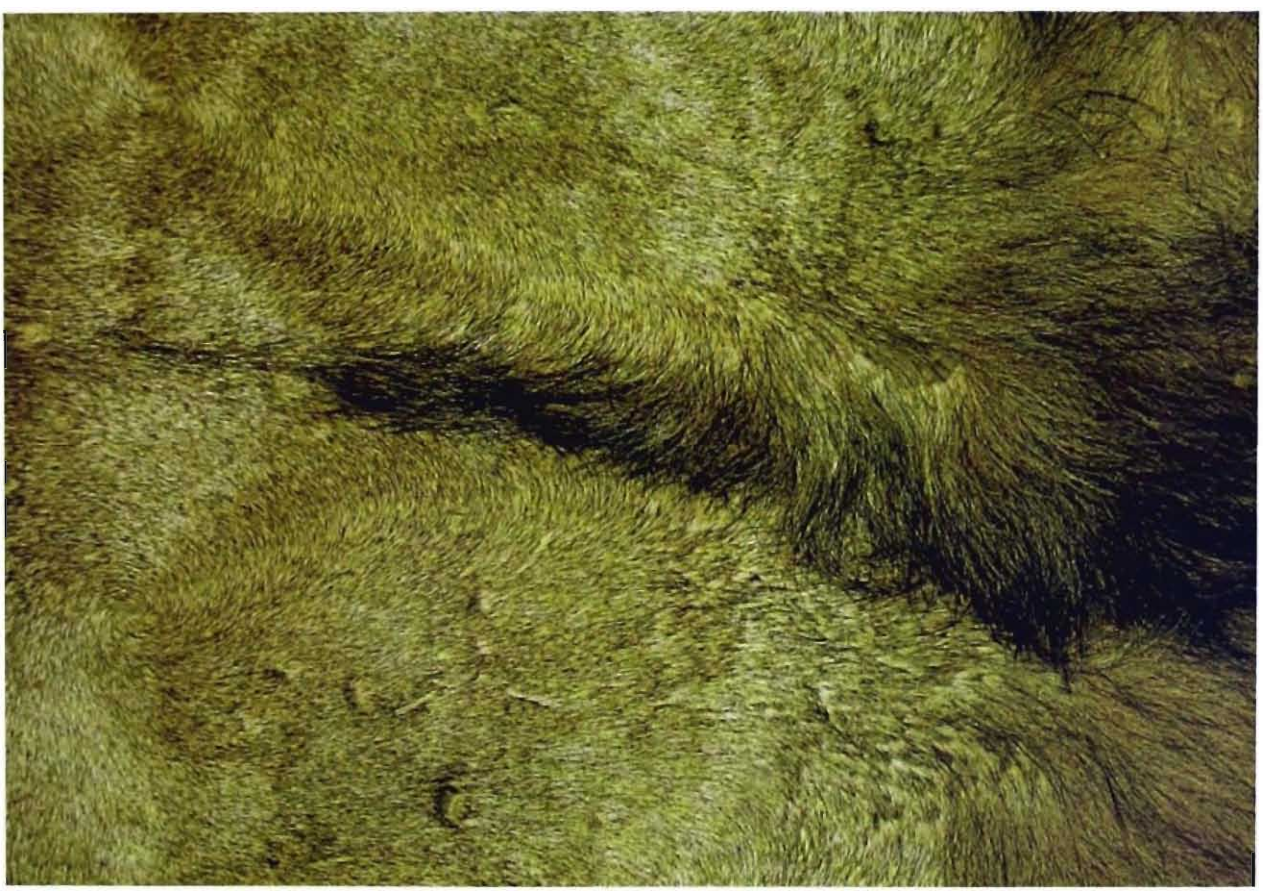
2. *Panthera leo* (Linnaeus)

Common name : Lion

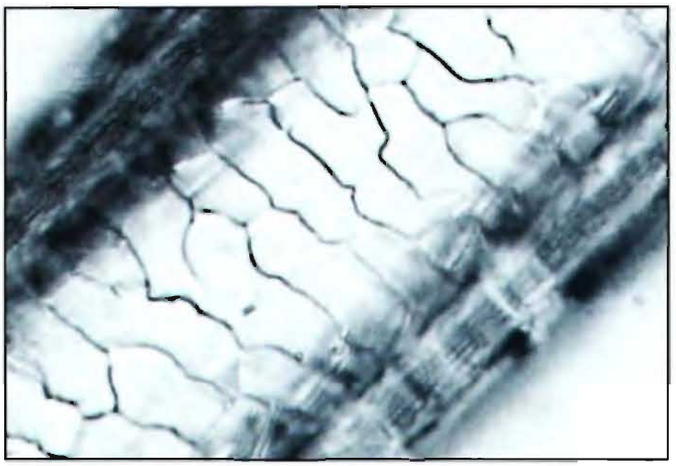
Coat colour : Coat sandy grey to tawny yellow without any markings on it; dark, saggy mane around the neck and shoulders, in male; a long tussel of hairs present at the end of tail.

Distribution : Gir forest in the State of Gujarat. *Extralimital* : Africa.

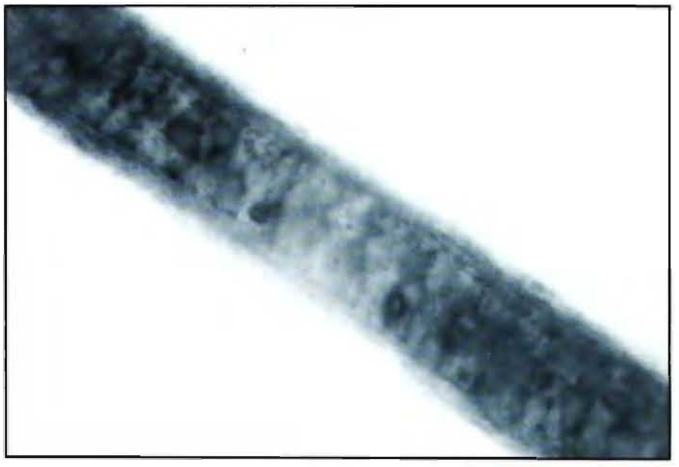
Characteristics of hair : *Colour* : Pale buff or yellow buff, with or without black tip or entirely black; *Profile* : Spatulate, straight, shielded, mane rod like and unshield; *Length* : 17-48 mm (39 ± 6), mane 80-160 mm (146 ± 7); *Diameter* : Basal : 30-50 µ (40 ± 6), Sub-shield : 50-60 µ (54 ± 3), Shield : 60-70 µ (66 ± 3); *Scale count/mm of hair length* : 192-260 (230); *Scale type* : Imbricate-flattened; *Scale Pattern* : Irregular waved mosaic; *Scale margin* : Smooth with little wave; *Scale margin distance* : Intermediate; *SS* : 19-48 µ (32 ± 8); *PD* : 7-10 µ (9 ± 1); *Medullary configuration* : Simple unbroken amorphous; *Medullary index* : 0.550-0.557 (0.553 ± 0.002); *Cross Section* : Circular.



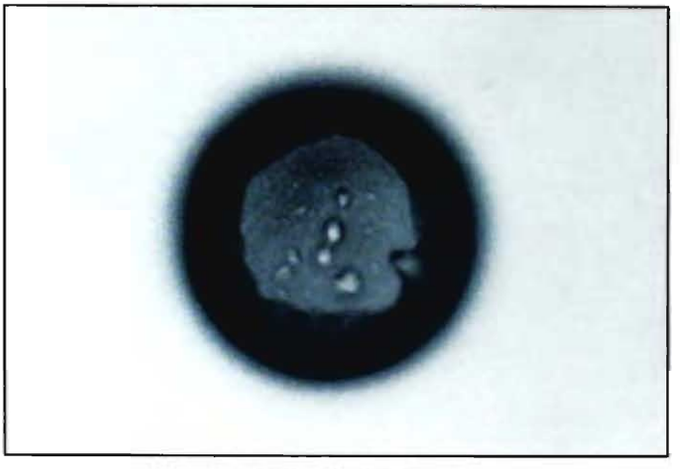
Pelage colour of Lion



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of *Panthera leo* (Linnaeus)

3. *Panthera pardus* (Linnaeus)

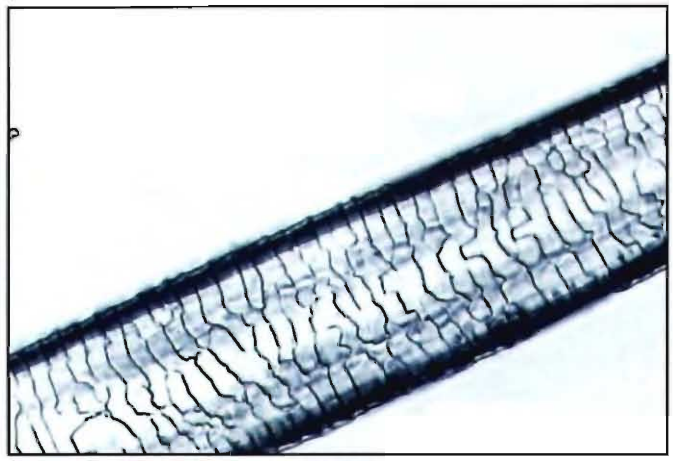
Common name : Leopard

Coat colour : Coat-colour cinnamon buff, marked with small close set black rosettes.

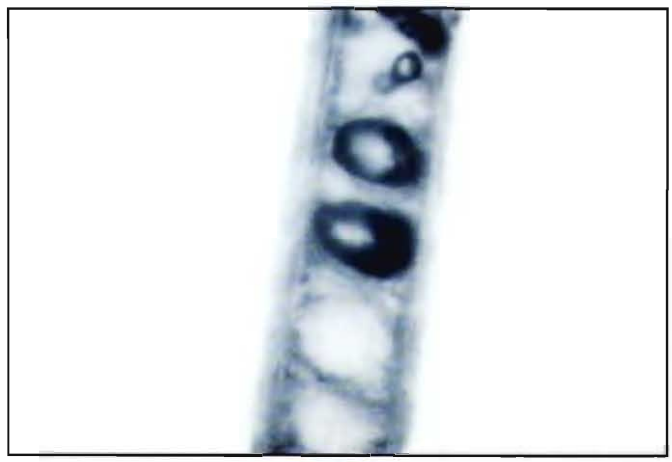
Distribution : Throughout India in suitable pockets. *Extralimital* : Africa, Asia except the high Tibetan Plateau.

Characteristics of hair : *Colour* : Rufous brown with or without black tip or entirely black; *Profile* : Spatulate, straight, shielded; *Length* : 8-32 mm (21 ± 6); *Diameter* : Basal : 20-40 μ (26 ± 4), Sub-shield : 40-50 μ (46 ± 2), Shield : 60-70 μ (58 ± 7); *Scale type* : Imbricate-flattened; *Scale Pattern* : Irregular waved mosaic; *Scale margin* : Irregularly waved with few notches; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 210-325 (275); *SS* : 20-40 (33 ± 5); *PD* : 7-14 (10 ± 3); *Medullary configuration* : Unbroken vacuolated; *Medullary index* : 0.657-0.668 (0.663 ± 0.004); *Cross Section* : Circular.

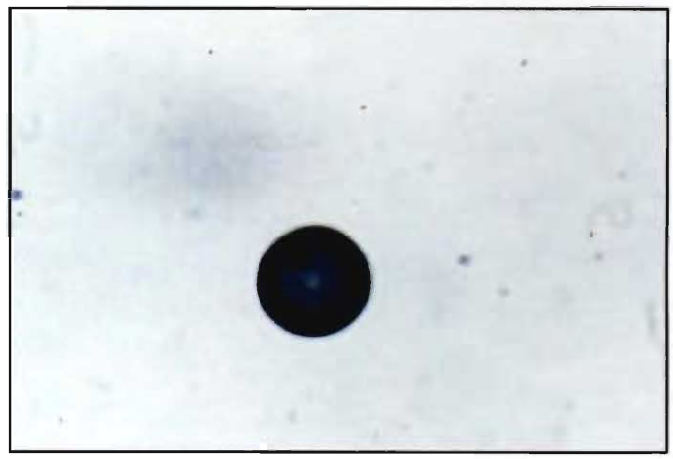
Pelage colour of Leopard



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Leopard, *Panthera pardus* (Linnaeus)

4. *Uncia uncia* (Schreber)

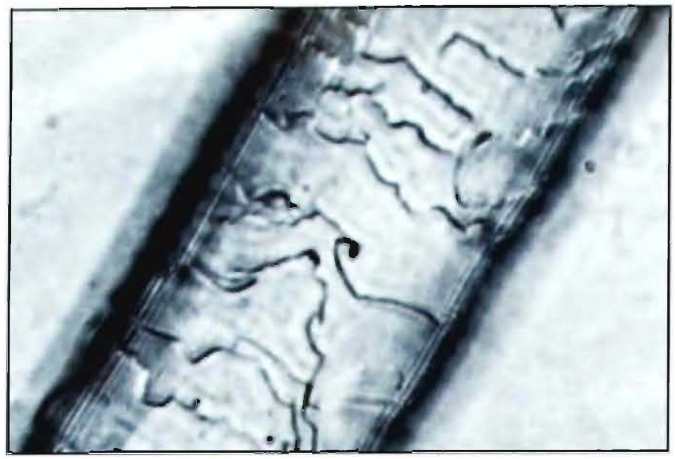
Common name : Snow Leopard

Coat colour : Grayish white coat with paler rosettes.

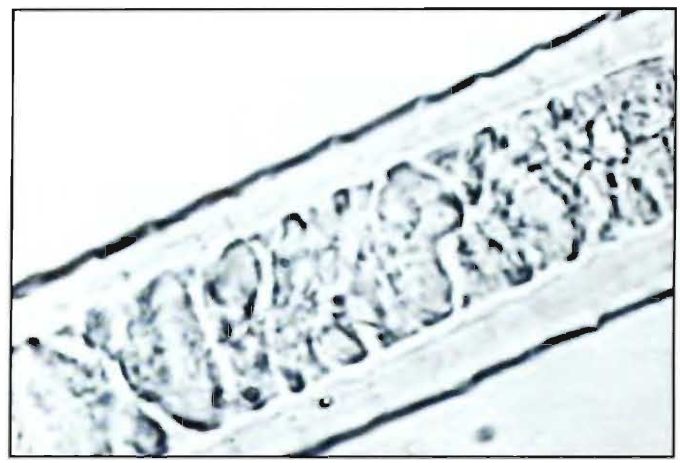
Distribution : In India from Kashmir to Arunachal Pradesh along the Himalayas. *Extralimital* : Afghanistan, Bhutan, China, CIS countries, Mongolia, Nepal, Pakistan.

Characteristics of hair : *Colour* : Basal white or pale Buff, rest of hair light Brown with or without dark tip; *Profile* : Spatulate, straight, shielded; *Length* : 19-44 mm; *Diameter* : B : 20 µ, Ssh : 20-40 µ (28 ± 3); S : 30-60 µ (42 ± 7); *Scale type* : Imbricate-crenate; *Scale Pattern* : Irregular wave; *Scale margin* : Irregularly rippled; *Scale margin distance* : Distant; *Scale count/mm of hair length* : 90-134 (115); *SS* : 21-30 µ (26 ± 3); *PD* : 9-22 µ (14 ± 4); *Medullary configuration* : Unbroken vacuolated; *Medullary index* : 0.659-0.672 (0.665 ± 0.005); *Cross Section* : Circular.

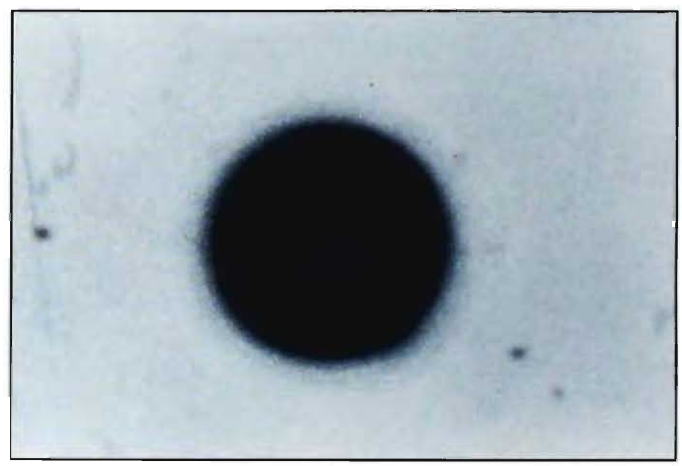
Pelage colour of Snow Leopard



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Snow Leopard, *Uncia uncia* (Schreber)

5. *Acinonyx jubatus venaticus* (Griffith)

Common name : Cheetah

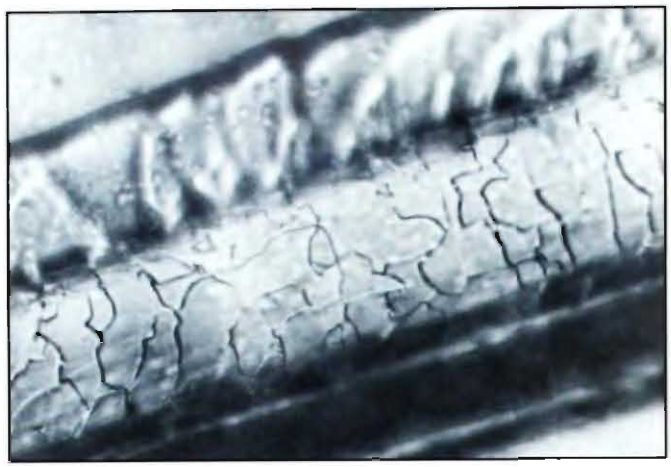
Coat colour : Coat colour from tawny to buff, with solid black spots set quite close together; a black stripe extends from the eye to the mouth on each side.

Distribution : Last record in India is from near Hyderabad in 1951 and near Chandragiri in southern India in 1952 (Alfred *et al.*, 2002). *Extralimital* : Northern Iran.

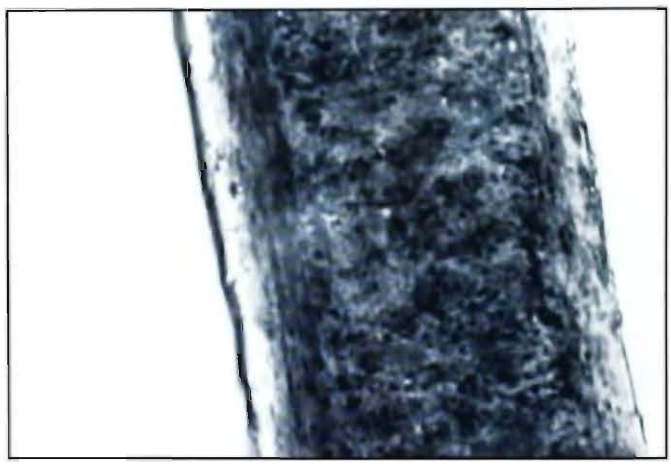
Characteristics of hair : *Colour* : B : Buff, M : Tawny, A : Brown; *Profile* : Thin, straight, rod like; *Length* : 37-47 mm (43.7 ± 2.07); *Diameter* : 50-65 µ (56 ± 3.56); *Scale type* : Imbricate-crenate; *Scale Pattern* : Irregular wave; *Scale margin* : Irregularly Rippled; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 435-538 (489); *SS* : 7.5-21.87 µ (14.81 ± 4.31); *PD* : 3.12-9.39 µ (5.25 ± 2.24); *Medullary configuration* : Simple unbroken amorphous; *Medullary index* : 0.62-0.66 (0.635 ± 0.001); *Cross Section* : Circular.

Remarks : Shades vary greatly. Whole hair may be light brown to dark tawny or more dark.

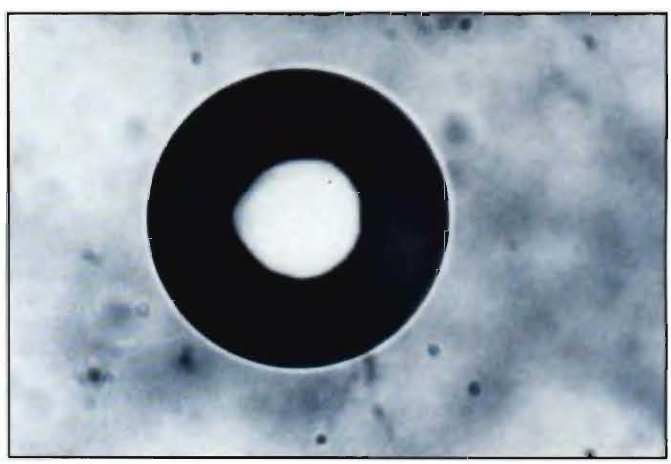
Pelage colour of Cheetah



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Cheetah, *Acinonyx jubatus venaticus* (Griffith)

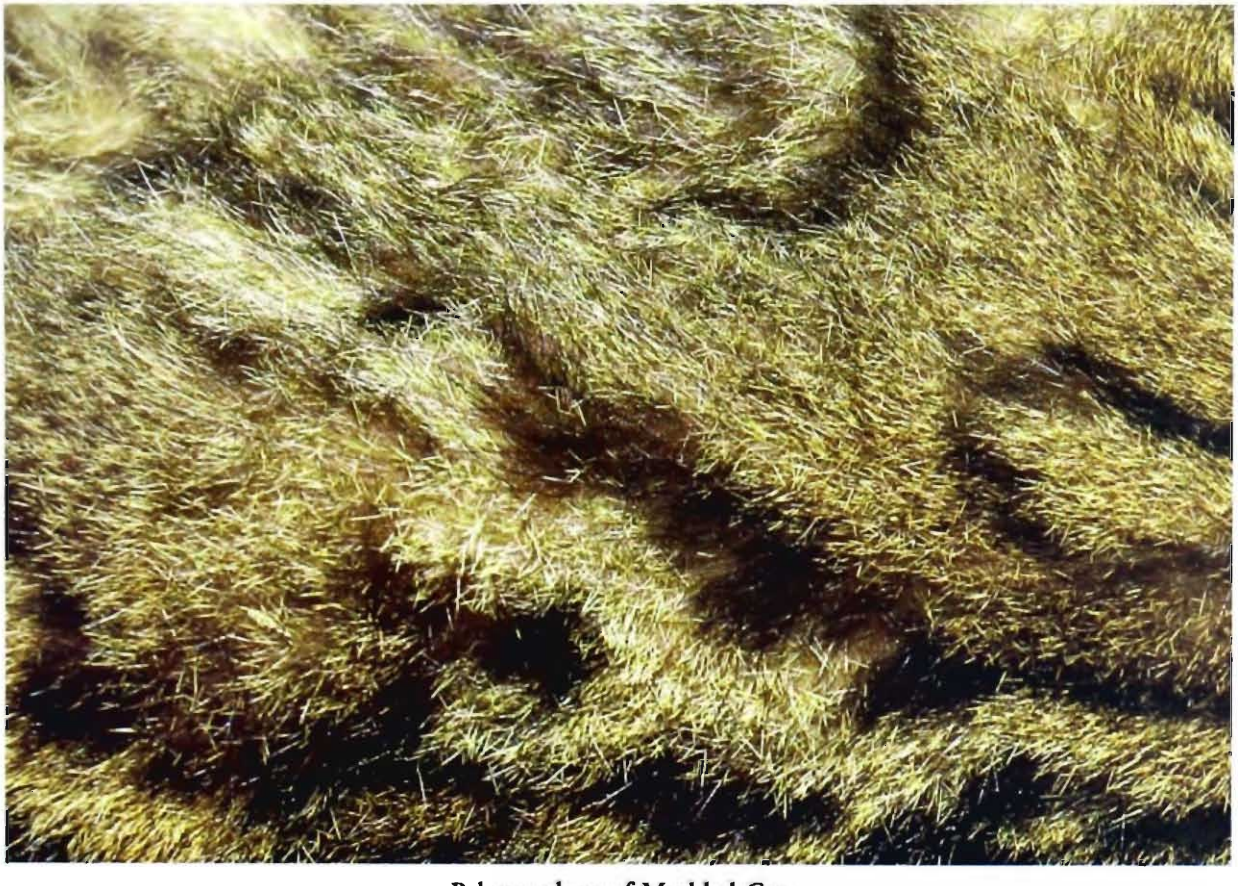
6. *Pardofelis marmorata* (Martin)

Common name : Marbled Cat

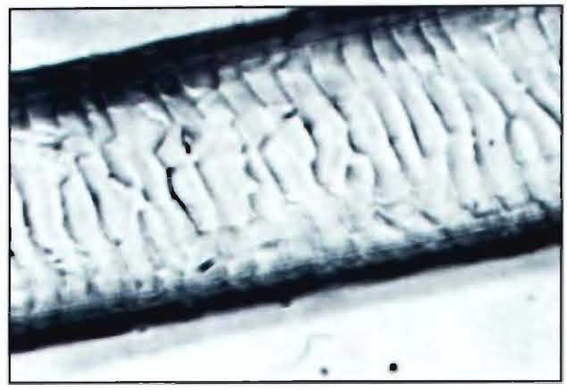
Coat colour : Rich ochraceous brown in colour with dark stripes and blotches which tends to show the marbled pattern.

Distribution : North-eastern India. *Extralimital* : China, Indonesia, Malayasia, Myanmar, Nepal to Vietnam, Thailand.

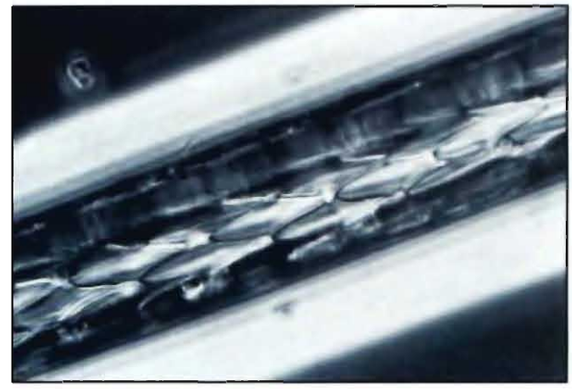
Characteristics of hair : *Colour* : Seal Brown or with a white or Cream Buff band slightly below the tip; *Profile* : Spatulate, Straight, Shielded; *Length* : 18-22 mm (20.2 ± 1.53); *No. of Band :* 1 or none; *Diameter* : B : 28-31 µ (30 ± 1.0), Ssh : 49-51 µ, (49.8 ± 0.748); S : 47-53 µ (50 ± 1.8); *Scale type* : B & Ssh : Imbricate flattened, S : Accuminate; *Scale Pattern* : B & Ssh : Regular wave, S : Diamond petal or broad petal; *Scale margin* : Smooth; *Scale margin distance* : B & Ssh : Intermediate, S : Distant; *Scale count/mm of hair length* : B : 527-583 (555), Ssh : 148-189 (164); S : 76-97 (89); *SS* : B : 7-17 µ (11.8 ± 1.08), Ssh : 12.5-17 µ (9.5 ± 1.62), S : 8-10 µ (9.5 ± 0.17); *PD* : B : 5-10 µ (5.8 ± 0.49), Ssh : 7-12 µ (9.8 ± 1.79), S : 19-25 µ (22 ± 1.91); *Medullary configuration* : Uniserial ladder; *Medullary index* : 0.54-0.60 (0.577 ± 0.004); *Cross Section* : Almost circular.



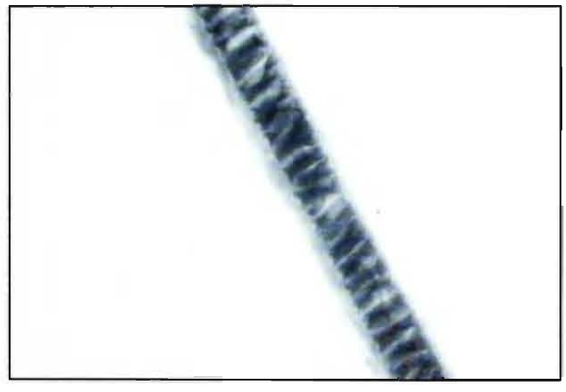
Pelage colour of Marbled Cat



Cuticle



Cuticle (Shield)



Medulla

Cross Section

Microstructure of dorsal guard hair of Marbled Cat, *Pardofelis marmorata* (Martin)

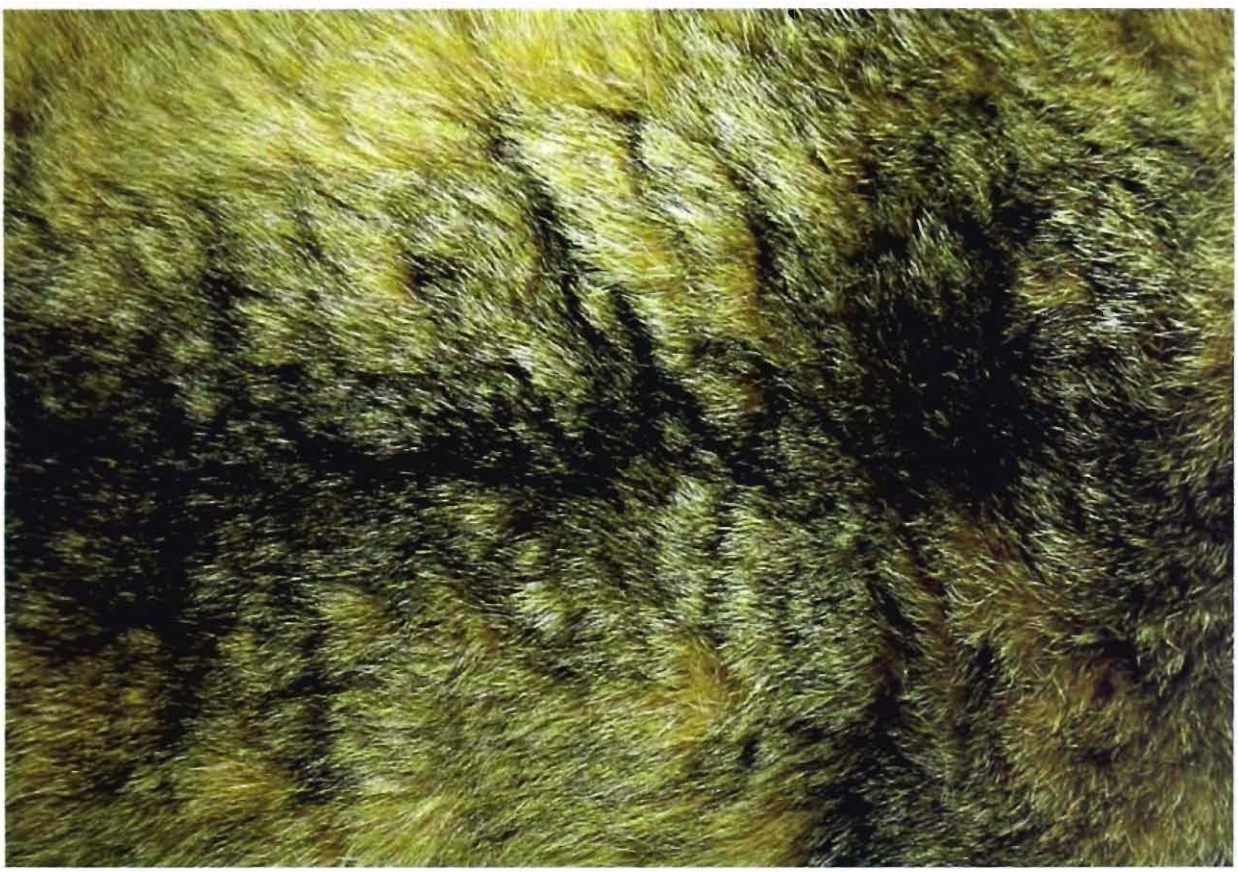
7. *Prionailurus rubiginosus* (I.Geoffroy Saint Hilaire)

Common name : Rusty-spotted Cat

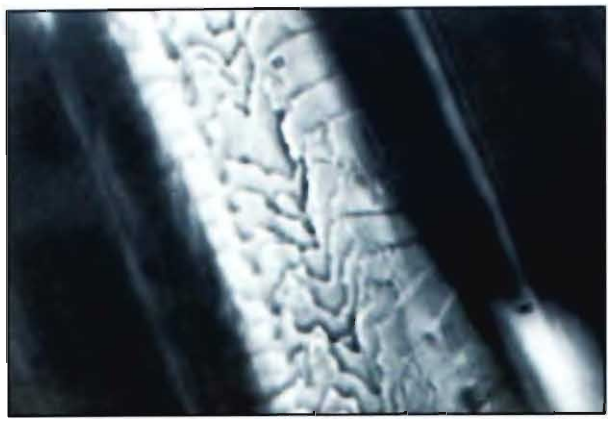
Coat colour : Fawn grey in colour with brown spots and lines arranged almost in linear pattern; markings on head and shoulder are dark brown.

Distribution : Its occurrence restricted in India to Andhra Pradesh, Gujarat, Jammu and Kashmir, Madhya Pradesh, Maharashtra, Pondicherry and Tamil Nadu. *Extralimital* : Sri Lanka.

Characteristics of hair : *Colour* : Seal brown, darkest at the widest portion & gradually being lighter towards the base or seal brown with a light tawny band below the tip; *Profile* : Spatulate, Straight, Shielded; *Length* : 11-19 mm (14.28 ± 2.37); *No. of Band* : 1or none; *Diameter* : B : 50 µ, Ssh : 48-55 µ (50 ± 1.8), S : 57-66 µ (60 ± 1.49); *Scale type* : B & Ssh : Imbricate-crenate S : Imbricate-flattened; *Scale Pattern* : B & Ssh : Irregular wave, S : Mosaic; *Scale margin* : B & Ssh : Rippled, S : Smooth; *Scale margin distance* : B : Close, Ssh : Intermediate, S : Distant; *Scale count/mm of hair length* : B : 575-615 (600), Ssh : 329-385 (350), S : 97-138 (123); *SS* : B : 8-16 µ (122 ± 3.1), Ssh : 10.5-28 µ (18.7 ± 4.2), S : 19-35 µ; (29.0 ± 1.9); *PD* : B : 4-7 µ (4.8 ± 0.23), Ssh : 4-10 µ (6.1 ± 1.4), S : 8-10.5 µ (9.125 ± 0.6); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.777-0.779 (0.778 ± 0.001); *Cross Section* : Ovate.

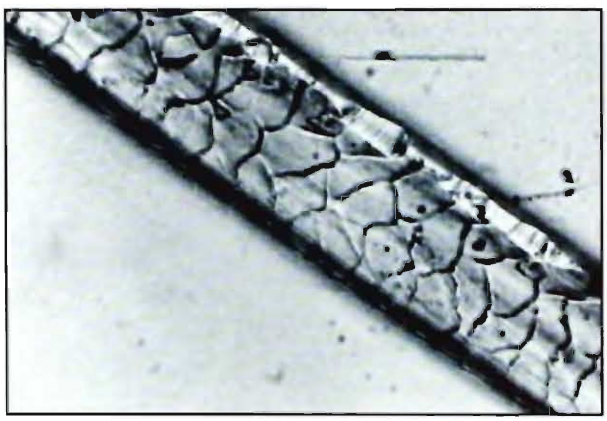


Pelage colour of Rusty-spotted Cat



Cuticle (Basal & Sub-shield)

Medulla



Cuticle (Shield)

Cross Section

Microstructure of dorsal guard hair of Rusty-spotted Cat, *Prionailurus rubiginosus* (I. Geoffroy-Saint Hilaire)

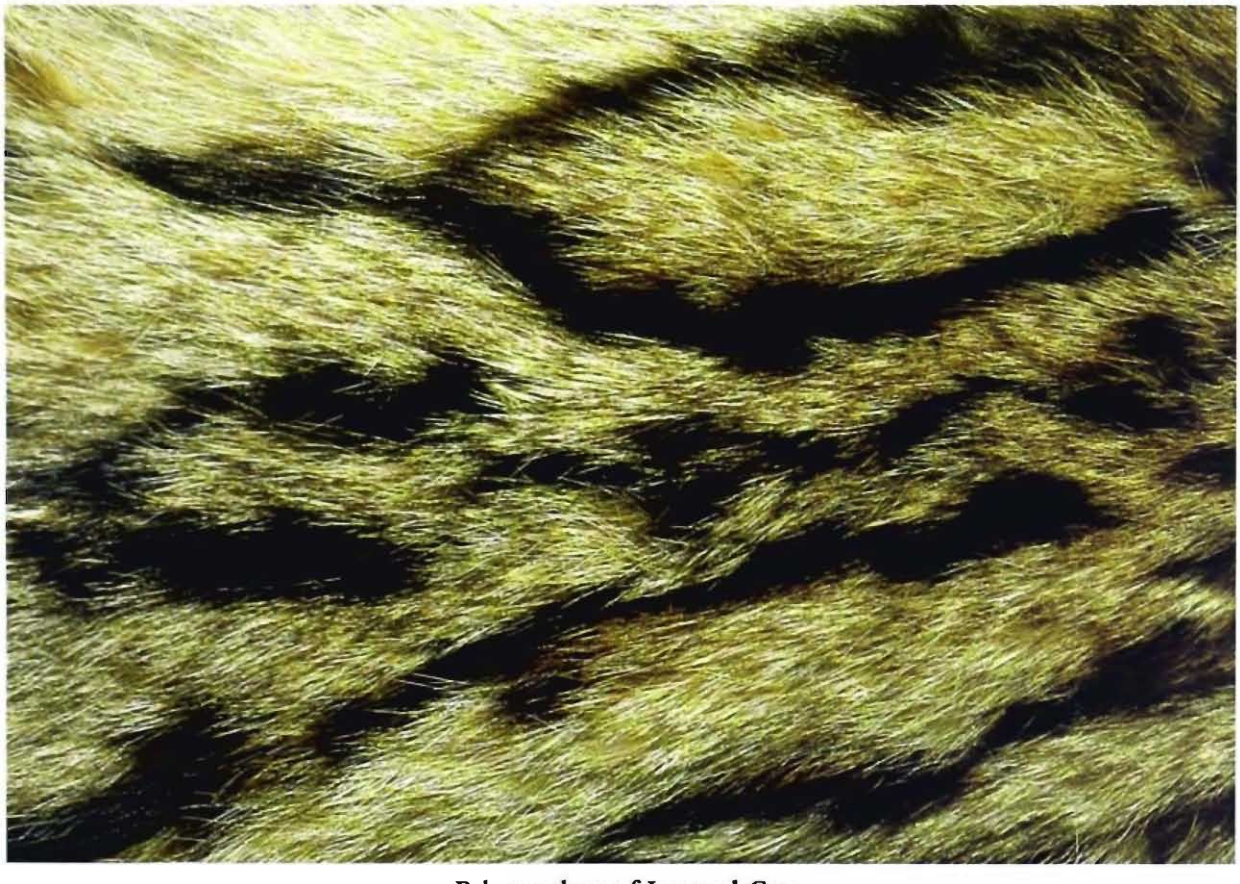
8. *Prionailurus bengalensis* (Kerr)

Common name : Leopard Cat

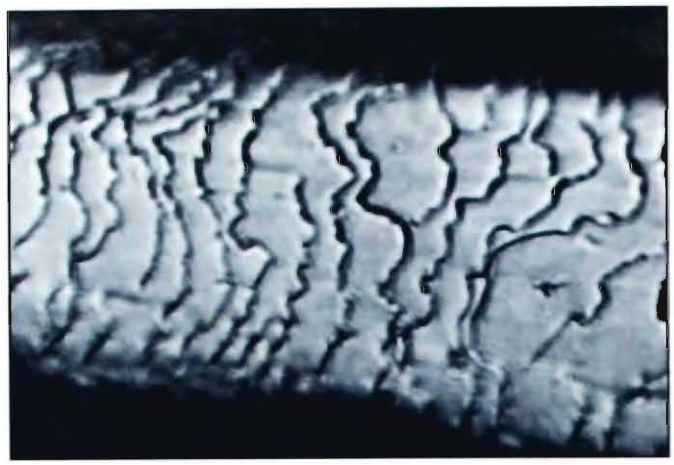
Coat colour : Coat yellowish above, white below, ornamented throughout with black or brownish spots; four distinct bands run from the crown over the neck.

Distribution : Forest regions of India from Kashmir and the Himalayas to Cape Comorin; *Extralimital* : Afghanistan, Bangladesh, China, Cambodia, Indonesia, Japan, Korea, Loas, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Taiwan, Thailand, Commonwealth of Independent States (old U.S.S.R.) and Vietnam.

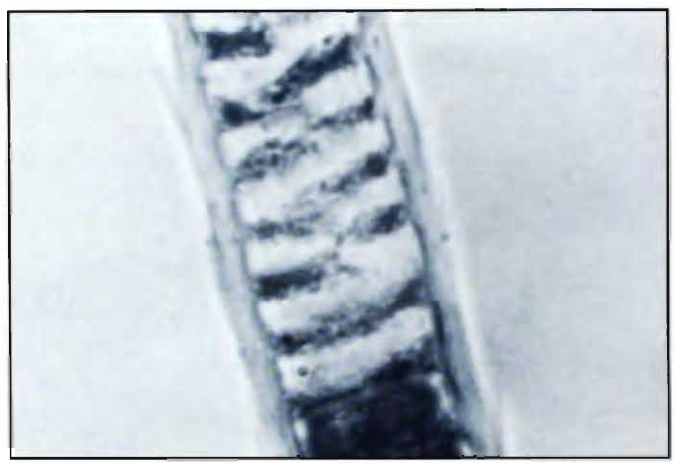
Characteristics of hair : *Colour* : Dark chestnut brown with lighter basal region or dark chestnut with light tawny band below the tip or tawny with dark chestnut tip; *Profile* : Spatulate, Straight, Shielded; *Length* : 12.6-18.9 mm (15.7 ± 1.2); *No. of Band* : 1 or none; *Diameter* : B : 47-56 µ (50 ± 2.7), Ssh : 60-90 µ (70 ± 2.9), S : 68-90 µ (78 ± 1.2); *Scale type* : Imbricate-crenate; *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Close; *Scale count/mm of hair length* : 570-630 (600); *SS* : 11-16 µ (12.4 ± 0.15); *PD* : 3-5 µ (4.2 ± 0.6); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.78-0.8 (0.79 ± 0.07); *Cross Section* : Ovate.



Pelage colour of Leopard Cat



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Leopard Cat, *Prionailurus bengalensis* (Kerr)

9. *Prionailurus viverrinus* (Bennett)

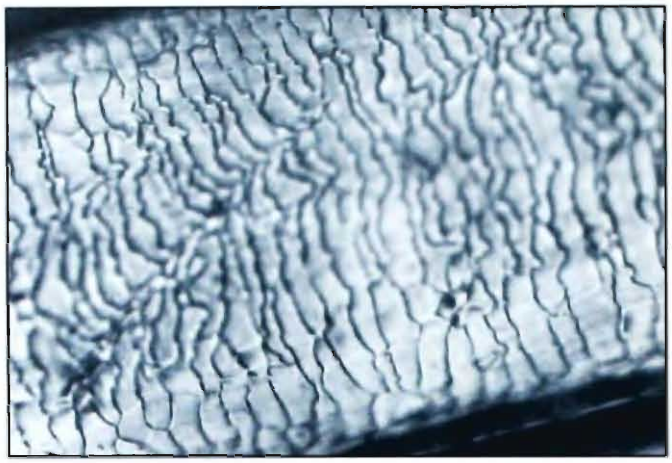
Common name : Fishing Cat

Coat colour : Coat earthy gray infused with brown; black or brown body markings consist of a series of elongate spots arranged in more or less longitudinal rows; six to eight dark lines run from the fore head over the crown on to the neck; tail distinctly ringed with black.

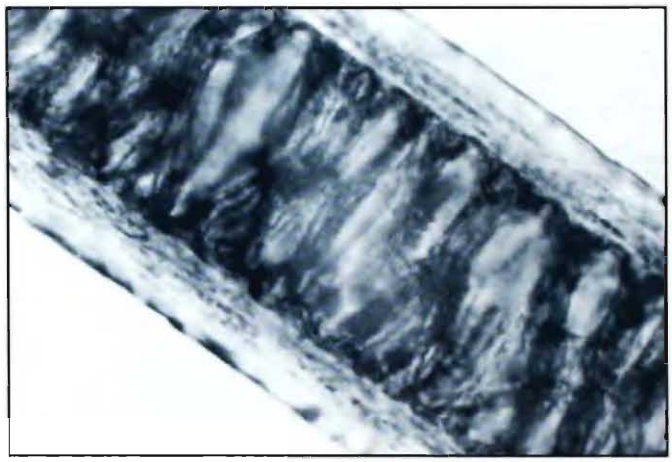
Distribution : In India, Andhra Pradesh, Assam, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal. *Extralimital* : Bangladesh, China, Indonesia, Malayasia, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand, Vietnam.

Characteristics of hair : *Colour* : Totally scarlet brown or with a cream buff band below the tip; *Profile* : Narrowly spatulate, Straight, Shielded; *Length* : 9-18 mm (13.97 ± 3.2); *No. of Band* : 1 or none; *Diameter* : B : 30-50 μ (43 ± 5.7), Ssh : 50-90 μ (60 ± 7.1), S : 50-90 μ (70 ± 5.9); *Scale type* : Imbricate-crenate; *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Close; *Scale count/mm of hair length* : 430-580; *SS* : 20-30 μ (24.0 ± 2.8); *PD* : 3-7 μ (4.8 ± 1); Medullary configuration : Unbroken cellular; Medullary index : 0.74-0.77 μ (0.75 ± 0.009); *Cross Section* : Ovate.

Pelage colour of Fishing Cat



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Fishing Cat, *Prionailurus viverrinus* (Bennett)

10. *Otocolobus manul* (Pallas)

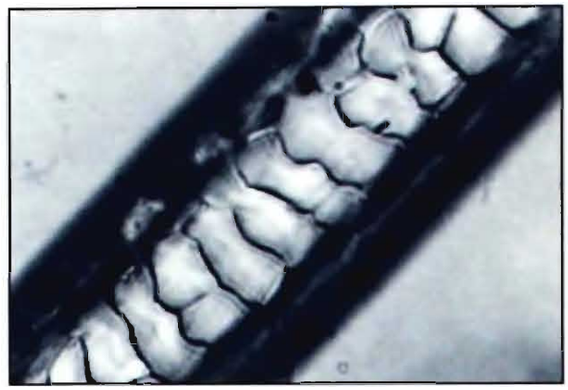
Common name : Palla's Cat

Coat colour : Colour silvery or iron gray; Hairs on the back are sooty black at the base, then white, and again black at the tip; dark transverse stripe on the loin some times on the limbs also; distal portion of the tail is ringed which ends in a black tip.

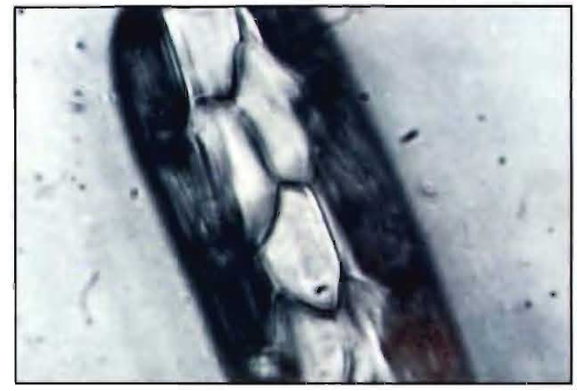
Distribution : Jammu and Kashmir in India. *Extralimital* : Caspian Sea to Himalaya, Transbaikalia, Afghanistan, China, Iran, Mongolia, Pakistan, Tibet.

Characteristics of hair : *Colour* : Chestnut brown or dark bay with a broad white apical band at the widest portion; *Profile* : Spatulate, Straight, Shielded; *No. of Band* : 1; *Length* : 21.5-32 mm (27.35 ± 2.83); *Diameter* : B : 20-30 μ (21 ± 0.02), Ssh : 20-30 μ (21 ± 0.08), S : 50-60 μ (61 ± 0.80); *Scale type* : Imbricate-flattened, apical-elongate; *Scale Pattern* : Regular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 286-418 (300); *SS* : 34-47 μ (39.2 ± 1.9); *PD* : 6-11μ (7.2 ± 0.6); *Medullary configuration* : Unbroken amorphous; *Medullary index* : 0.60-0.63 (0.62 ± 0.006); *Cross Section* : Oblong.

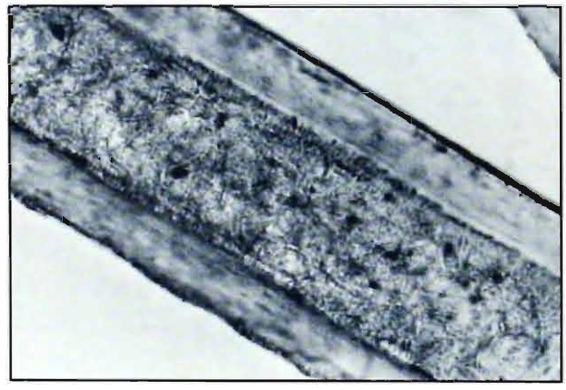
Pelage colour of Palla's Cat



Cuticle (Sub-shield)



Cuticle (Apical)



Medulla

Cross Section

Microstructure of dorsal guard hair of Palla's Cat, *Otocolobus manul* (Pallas)

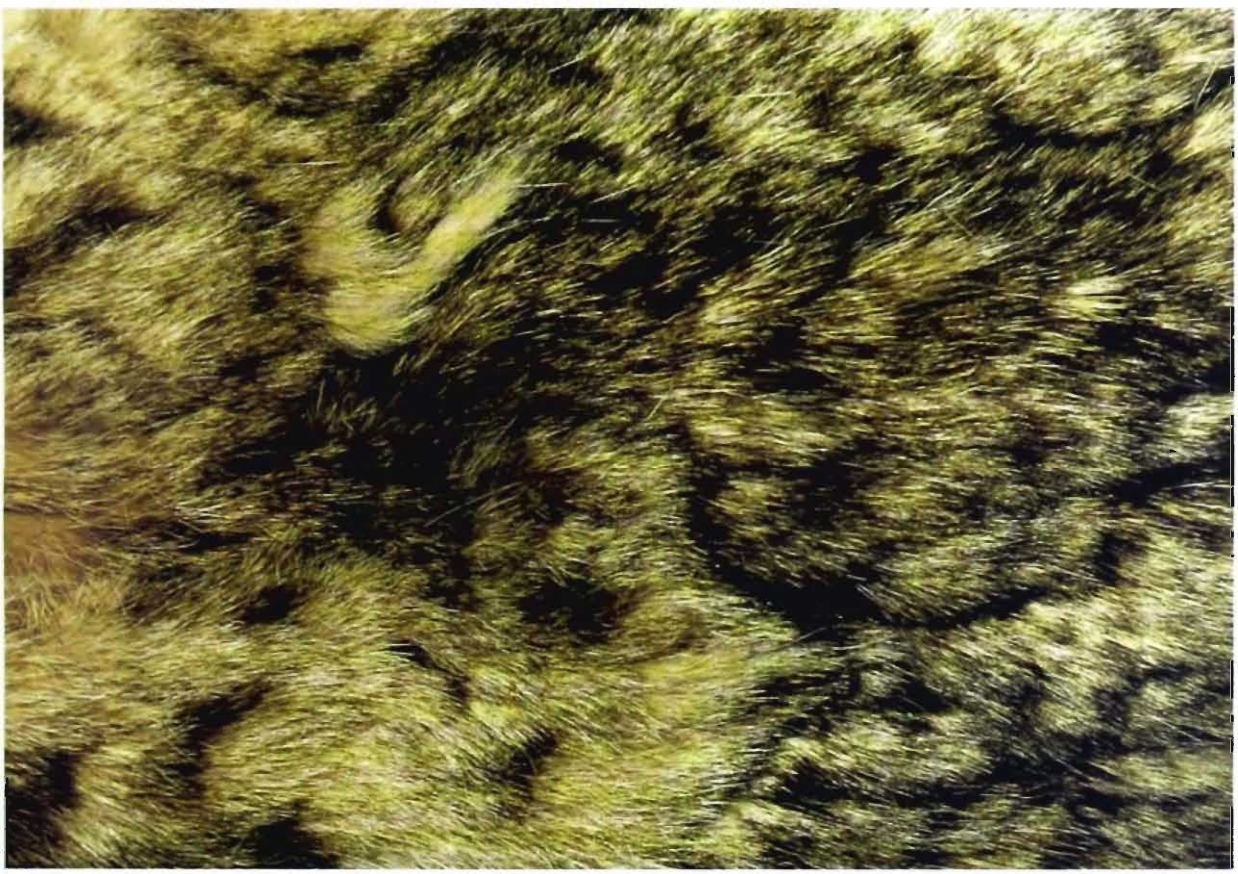
11. *Felis silvestris* Schreber

Common name : Desert Cat

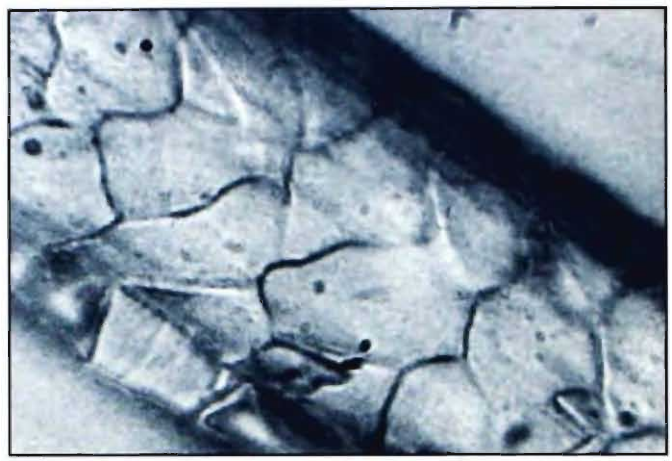
Coat colour : Coat pale yellow with numerous black spots; terminal half of the tail is ringed with black; two horizontal stripes on the cheeks; numerous dark cross lines on the outside of the limbs; two distinct black bars on the inner side of each forearm; chin, throat and breast white and without any spot; few black hairs on the ear tip.

Distribution : North-western and central India. *Extralimital* : In Pakistan from Sind west to northern Africa and northwards into the steppes of central Asia.

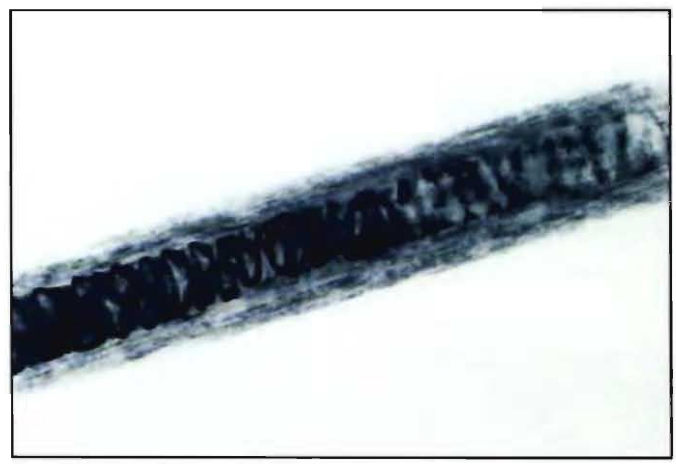
Characteristics of hair : *Colour* : Dark buff or light yellow with creamy buff band at the apical portion; *Profile* : Spatulate, Straight, Shielded; *Length* : 18-24.5 mm (21.16 ± 2.08); *No. of Band* : Usually 1, rarely 2; *Diameter* : B : 20 µ, Ssh : 20-30 µ (22 ± 1.01), S : 40-60 µ (47 ± 4.06); *Scale type* : Diamond petal or imbricate ovate; *Scale Pattern* : Regular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Distant; *Scale count/mm of hair length* : 152-196 (178); *SS* : 20-34 µ (26 ± 4.937); *PD* : 17-24 µ (19.85 ± 1.816); *Medullary configuration* : Uniserial ladder; *Medullary index* : 0.75-0.76 (0.755 ± 0.00025); *Cross Section* : Circular.



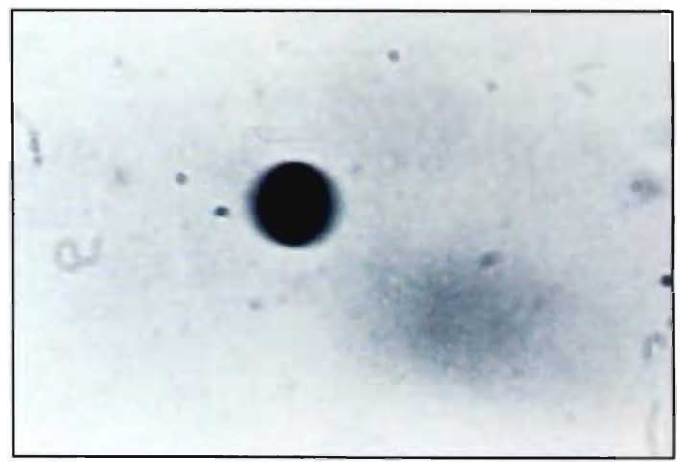
Pelage colour of Desert Cat



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Desert Cat, *Felis silvestris* Schreber

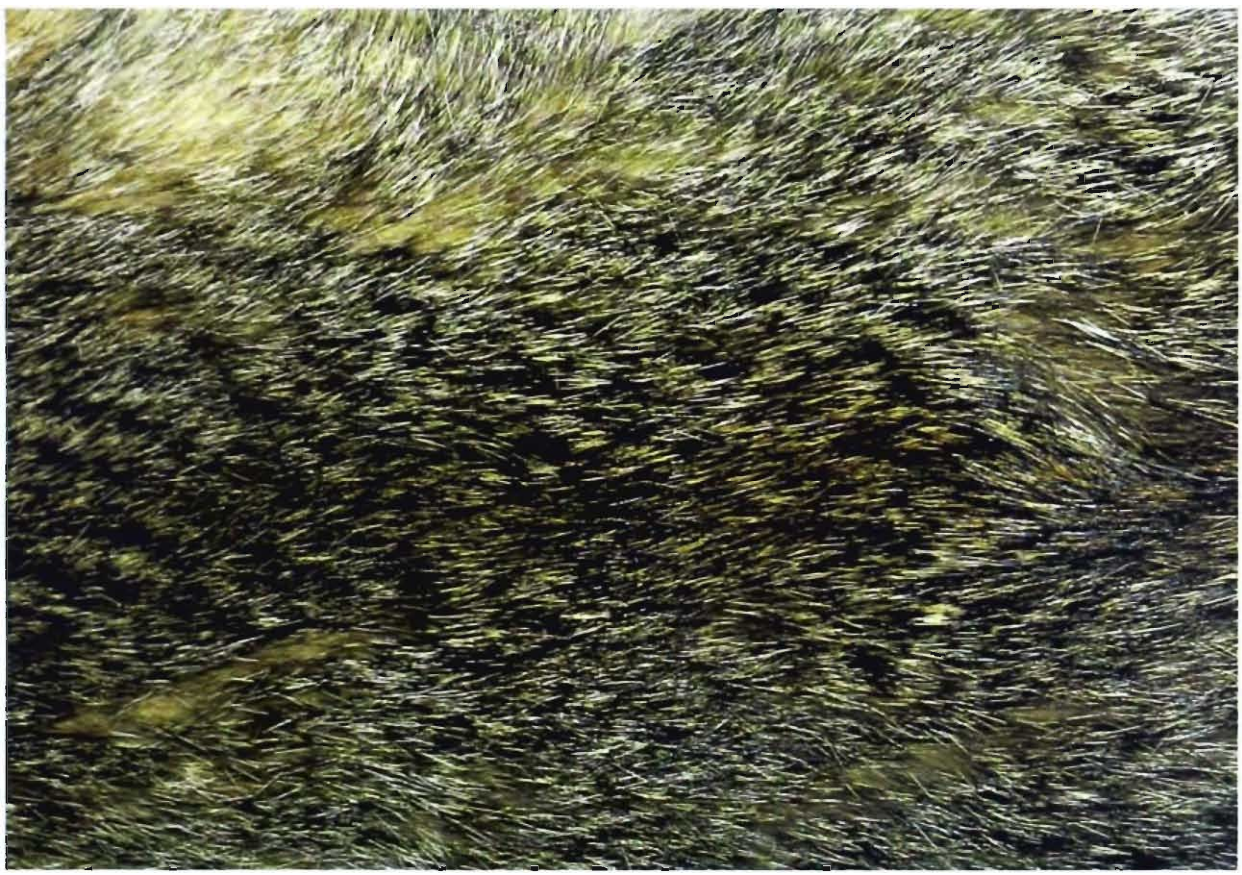
12. *Felis chaus* Schreber

Common name : Jungle Cat

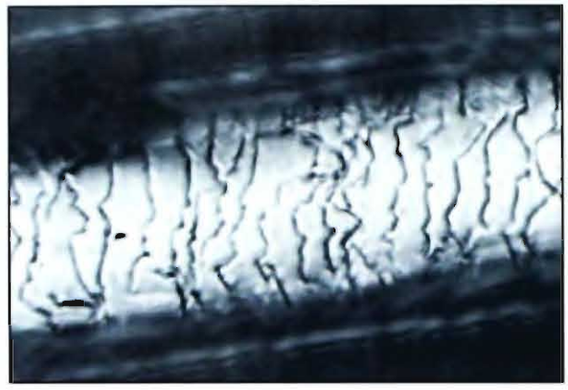
Coat colour : Colour varies from sandy grey to yellowish grey; tail is ringed with black to wards the end and has a black tip, the paws are pale yellowish, black or sooty brown underneath; ears are reddish, ending in a small pencil of black hairs; underside of the body is paler, with vestiges of stripes on the underside and flanks.

Distribution : Almost throughout the country. *Extralimital* : Afghanistan, Algeria, Arabia, Bangladesh, China, Egypt, Iran, Iraq, Israel, Kenya, Malawi, Morocco, Mojambique, Myanmar, Nepal, Pakistan, Sri Lanka, Syria, Thailand, Vietnam, Yemen, Zambia, Zimbabwe, CIS countries.

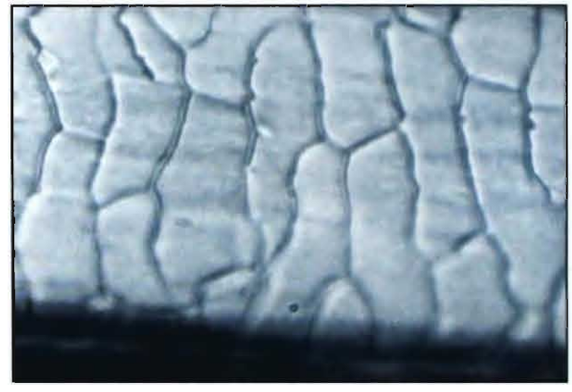
Characteristics of hair : *Colour* : Alternately banded with Prout's brown and olive buff or cream buff; tip dark and base lighter in shade; *Profile* : Almost rod like, usually 3-4 constrictions along the length of the hair; *Length* : 26-47 mm (39.5 ± 2.23); *No. of Band* : 4; *Diameter* : 30-55 µ (48 ± 5.6); *Scale type* : B : Imbricate-crenate, S & Ssh : Imbricate-flattened; *Scale Pattern* : B : Irregular wave, S & Ssh : Mosaic; *Scale margin* : B : Crenate, S & Ssh : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : B : 536-692 (672), Ssh : 326-562 (481), S : 331-549 (483); *SS* : B : 21-44 µ (31.6 ± 6.68), Ssh : 27-50 µ (39.7 ± 7.3), S : 24-35 µ (28 ± 3.5); *PD* : B : 3-11.5 µ (6.6 ± 2.54), Ssh : 10-15.5 µ (10.8 ± 1.9); S : 8-14 µ (11.45 ± 2.45); *Medullary configuration* : Unbroken vacuolated; *Medullary index* : 0.684-0.71 (0.699 ± 0.004); *Cross Section* : Ovate.



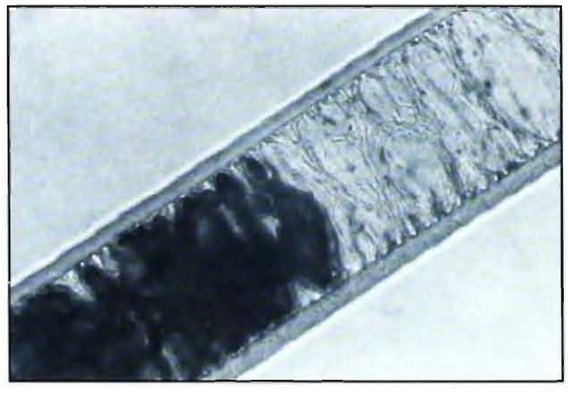
Pelage colour of Jungle Cat



Cuticle (Basal)



Cuticle (Shield & Sub-shield)



Medulla

Cross Section

Microstructure of dorsal guard hair of Jungle Cat, *Felis chaus* Schreber

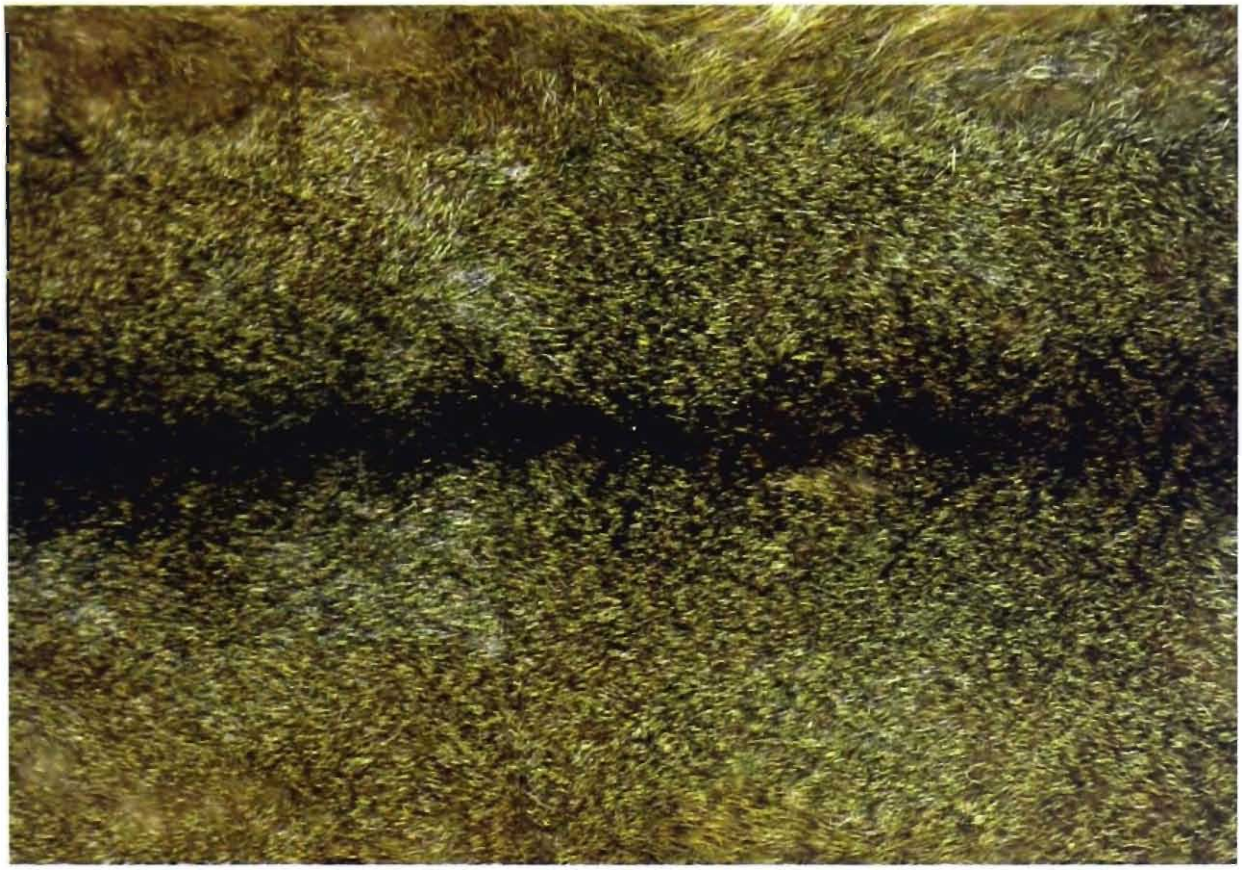
13. *Catopuma temminckii* (Vigors & Horsfield)

Common name : Golden Cat

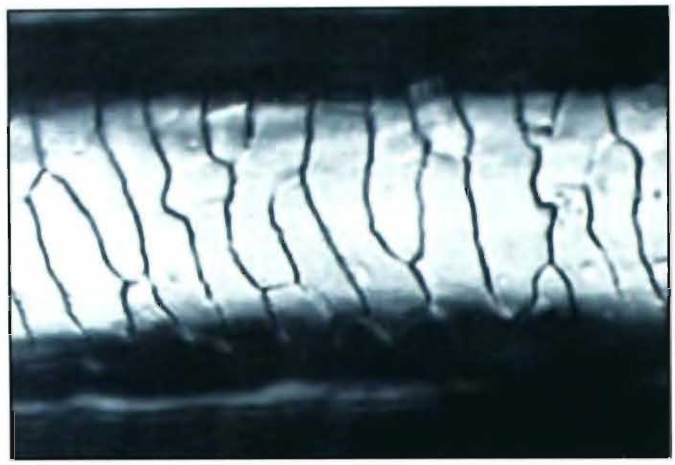
Coat colour : Coat golden brown to dark brown, without any trace of pattern on it; faint stripes present on the shoulders; flanks and face, most conspicuous being a horizontal white cheek stripe running from below the eye to behind the gape.

Distribution : Sikkim to northeastern India. *Extralimital* : Bangladesh, Cambodia, China, Indonesia, Laos, Malaysia, Myanmar, Nepal, Thailand, Vietnam.

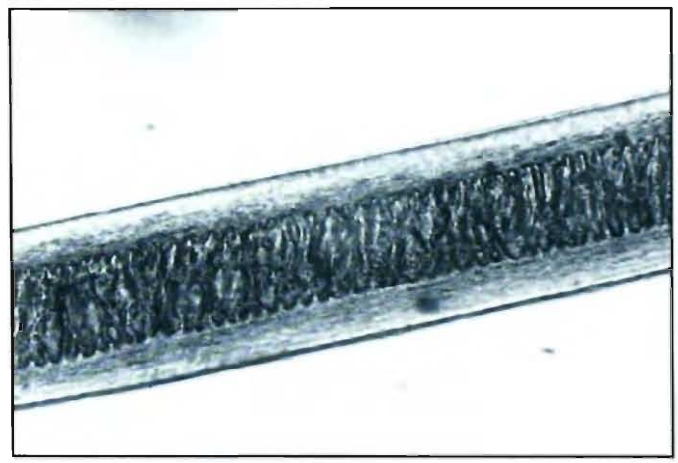
Characteristics of hair : *Colour* : Upper shaft brunt umber, lower shaft tawny; *Profile* : Spatulate, Straight, Shielded; *Length* : 7.5-15 mm (11.11 ± 1.52); *No. of Band* : Nil; *Diameter* : B : 50 µ, Ssh : 50-90 µ (64 ± 3.84), S : 60-90 µ (72 ± 2.66); *Scale type* : Imbricate-flattened; *Scale Pattern* : Regular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 227-306 (263); *SS* : 26-31 µ (29 ± 1.89); *PD* : 6-10 µ (7.6 ± 1.03); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.59-0.60 (0.595 ± 0.0026); *Cross Section* : Almost Circular.



Pelage colour of Golden Cat



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Golden Cat, *Catopuma temminckii* (Vigors & Horsfield)

14. *Caracal caracal* (Schreber)

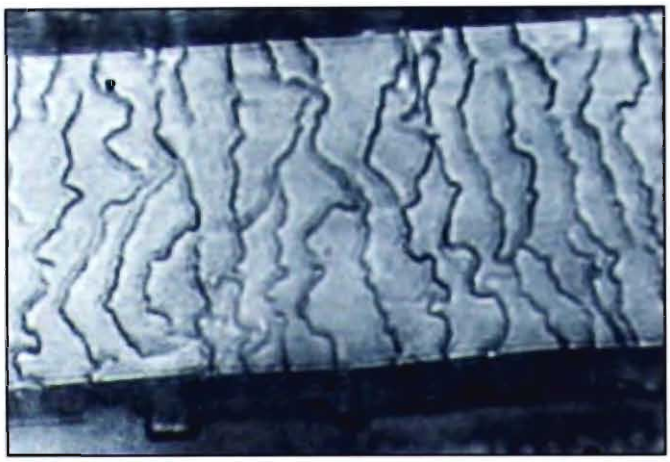
Common name : Caracal

Coat colour : Coat colour reddish gray above, buff below; faint indications of spots are present on the undersurface and sometimes on the back.

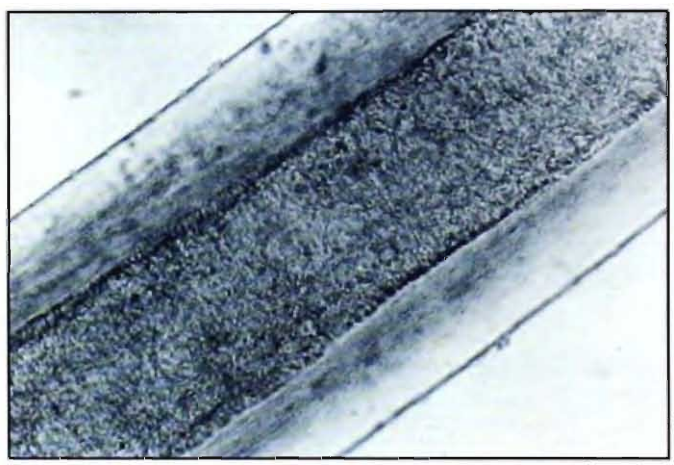
Distribution : In India, Gujarat, Madhya Pradesh, Rajasthan and Uttar Pradesh. *Extralimital* : From Pakistan west to Arabia and greater part of Africa.

Characteristics of hair : *Colour* : Dark chocolate brown, basal Russet; *Profile* : Spatulate, Straight, Shielded; *Length* : 7-13 mm (10.7 ± 2.08); *No. of Band* : Nil; *Diameter* : B : 50-70 µ (56 ± 3.07), Ssh : 50-60 µ (54 ± 0.98), S : 50-90 µ (66 ± 1.28); *Scale type* : Imbricate-crenate; *Scale Pattern* : Irregular wave mosaic; *Scale margin* : Crenate; *Scale margin distance* : Close; *Scale count/mm of hair length* : 528-580 (556); *SS* : 16-28 µ (23.9 ± 1.29); *PD* : 4-10 µ (5.1 ± 0.6); *Medullary configuration* : Unbroken amorphous; *Medullary index* : 0.80-0.82 (0.805 ± 0.0001); *Cross Section* : Ovate.

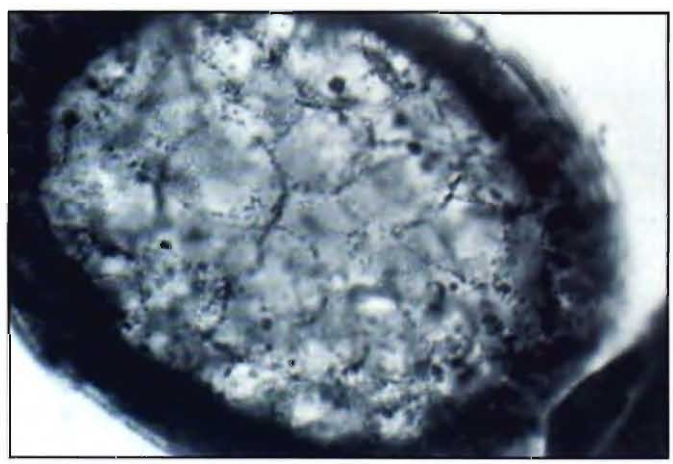
Pelage colour of Caracal



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Caracal, *Caracal caracal* (Schreber)

15. *Lynx lynx* (Linnaeus)

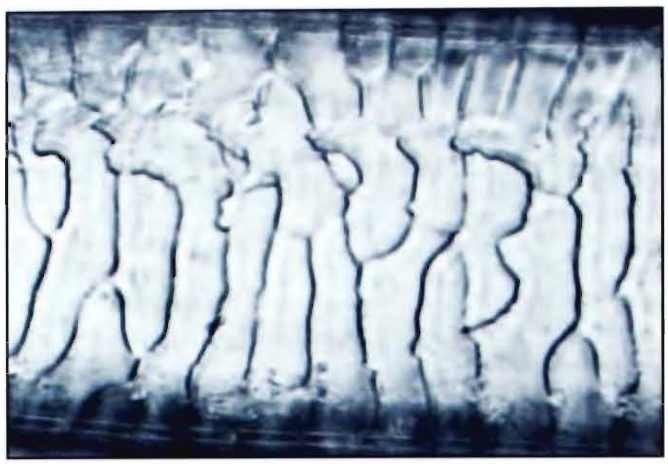
Common name : Lynx

Coat colour : Colour reddish or dark sandy gray; in summer the coat shows a sprinkling of spots which may persist, but usually disappear in winter.

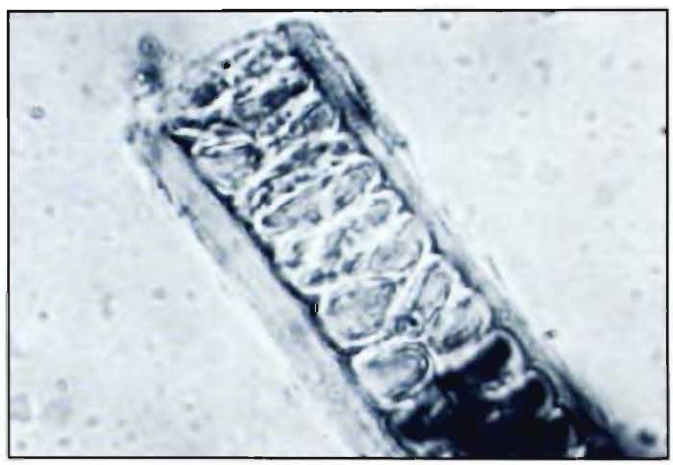
Distribution : Kashmir in India. *Extralimital* : From Scandinavia to eastern Siberia and northeastern China, Europe, Asia Minor through mountains of Central Asia.

Characteristics of hair : *Colour* : Apical dark seal brown and alternately banded with cream buff; *Profile* : Almost rod like, with constriction at cream buff banded regions; *Length* : 19.7-35 mm (29.2±3.06); *No. of Band* : 5; *Diameter* : Dark seal brown band region : 45-60 µ (54±3.2), Cream buff band region : 40-48 µ (43±2.4); *Scale type* : Imbricate flattened; *Scale Pattern* : Regular wave; *Scale margin* : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 190-245 (232); *SS* : 14-42 µ (30.4 ± 4.1); *PD* : 5-8 µ (6.4 ± 1.01); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.774-0.848 (0.806 ± 0.0304); *Cross Section* : Ovate.

Pelage colour of Lynx



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Lynx, ***Lynx lynx*** (Linnaeus)

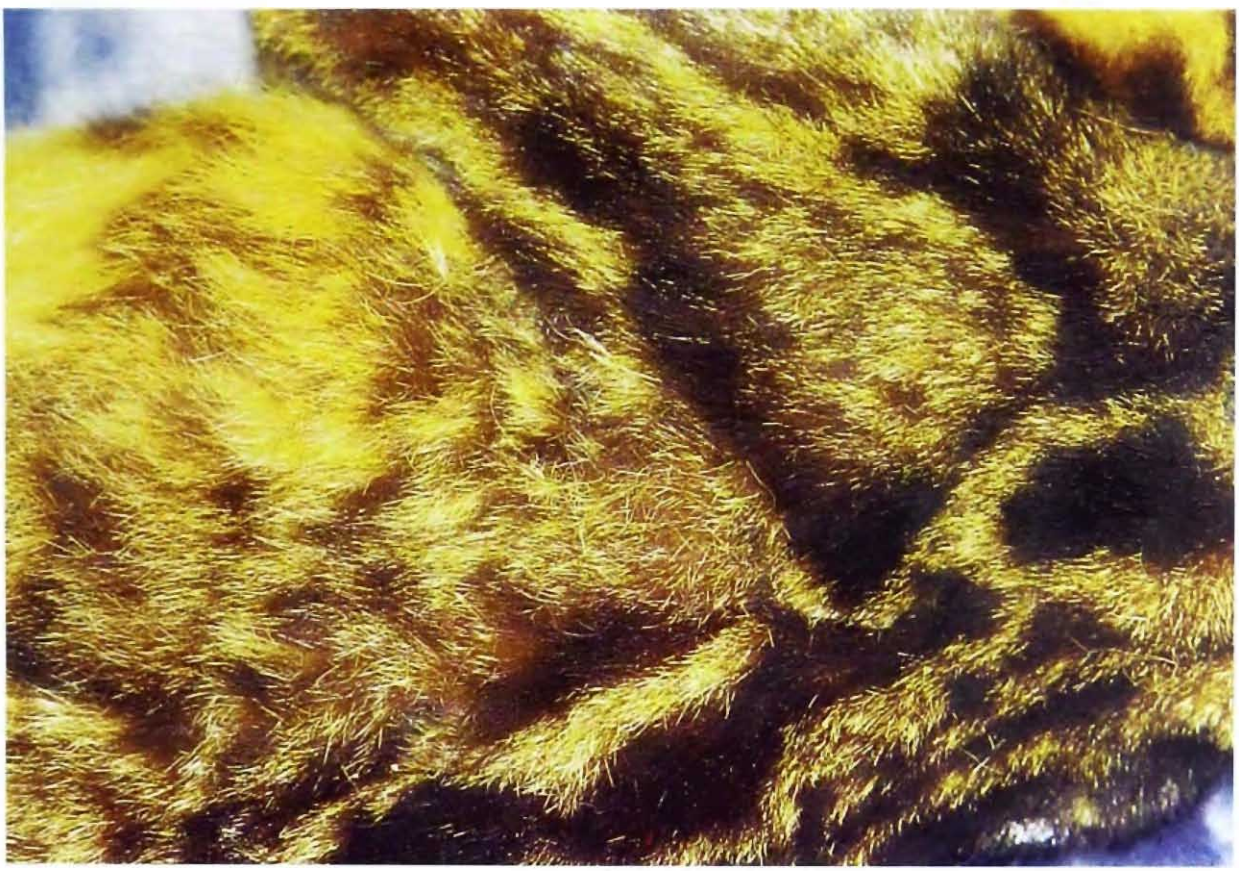
16. *Neofelis nebulosa* (Griffith)

Common name : Clouded Leopard

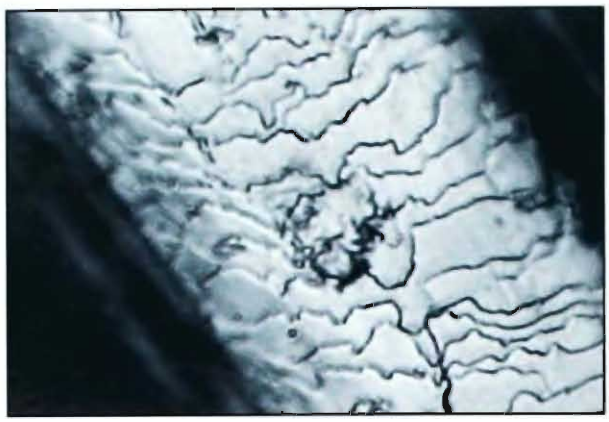
Coat colour : Coat colour varies from grey to earthy brown, marked with black-bordered irregular rosettes; head spotted and face with cheek stripes; tail ornamented with rings.

Distribution : In India, Sikkim to NE states. *Extralimital* : Cambodia, China, Indonesia, Malaysia, Myanmar, Nepal, Taiwan, Thailand and Vietnam.

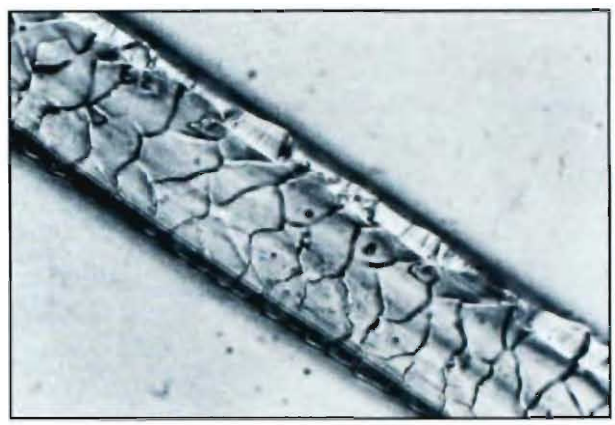
Characteristics of hair : *Colour* : Dark chocolate brown; *Profile* : Spatulate, Straight, Shielded; *Length* : 11-17 mm (13.2 ± 2.16); *No. of Band* : Nil; *Diameter* : B : 25-40 µ (30 ± 2.8), Ssh : 40-60 µ (50 ± 1.6), S : 50-80 µ (70 ± 4.8); *Scale type* : B & Ssh : Imbricate-crenate, S : Imbricate-flattened; *Scale Pattern* : B & Ssh : Irregular wave, S : Mosaic; *Scale margin* : B & Ssh : Crenate, S : Smooth; *Scale margin distance* : B & Ssh : Intermediate, S : Distant; *Scale count/mm of hair length* : B : 514-792 (682), Ssh : 409-596 (476), S : 300-445 (386); *SS* : B : 23-49 µ (33 ± 9.1), Ssh : 12-23 µ (16.75 ± 2.8), S : 11-36 µ (20.35 ± 6.81); *PD* : B : 2.5-8.0 µ (7.65 ± 2.75), Ssh : 4.5-7 µ (6.1 ± 0.94), S : 7.0-11.5 µ (9.55 ± 1.44), *Medullary configuration* : Unbroken vacuolated; *Medullary index* : 0.608-0.63 (0.62 ± 0.008); *Cross Section* : Ovate.



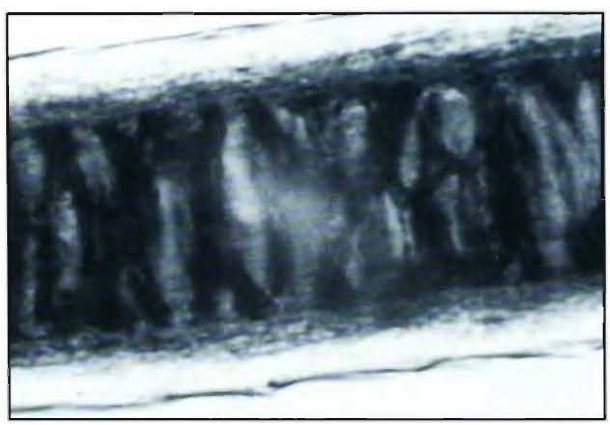
Pelage colour of Clouded Leopard



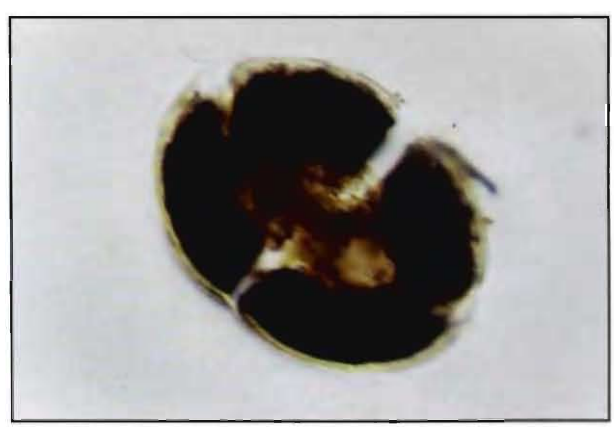
Cuticle (Basal & Sub-shield)



Cuticle (Shield)



Medulla



Cross Section

Microstructure of dorsal guard hair of Clouded Leopard, *Neofelis nebulosa* (Griffith)

17. *Ursus arctos* Linnaeus

II. Family URSIDAE

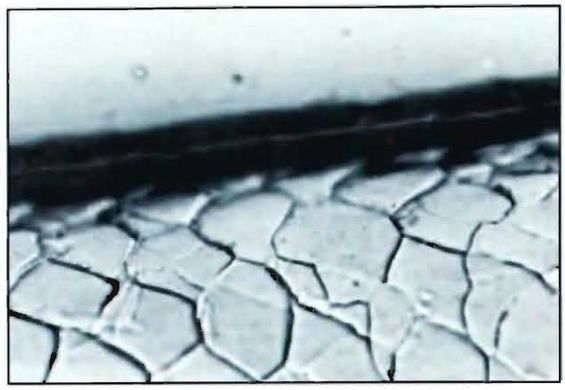
Common name : Brown Bear

Coat colour : Coat brown, heavily furnished with underwool in winter.

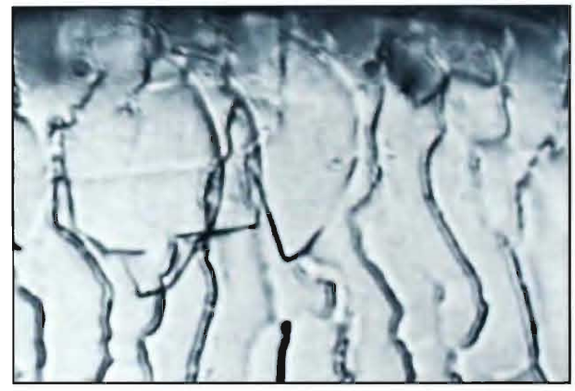
Distribution : In India higher reaches of Jammu-Kashmir and Himachal Pradesh. *Extralimital* : Almost whole of North Temperate Zone in Asia, Europe and North America.

Characteristics of hair : *Colour* : Seal to clove brown; *Profile* : Spatulate, Straight, Shielded, A : curly; *Length* : 65-71 µ (68.8 ± 2.08); *No. of Band* : One or rarely absent; *Diameter* : A : 50-100 µ (73.75 ± 9.15), S : 100-150 µ (121.25 ± 16.02), B : 90-120 µ (101.25 ± 9.27); *Scale type* : Imbricate-Smooth; *Scale Pattern* : B & Ssh : Irregular wave, S : Irregular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 290-360 µ (310 ± 9.25); *SS* : 20-40 µ (34 ± 4.95); *PD* : 10-30 µ (18 ± 5.44); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.32-0.34 (0.33 ± 0.012); *Cross Section* : Oval.

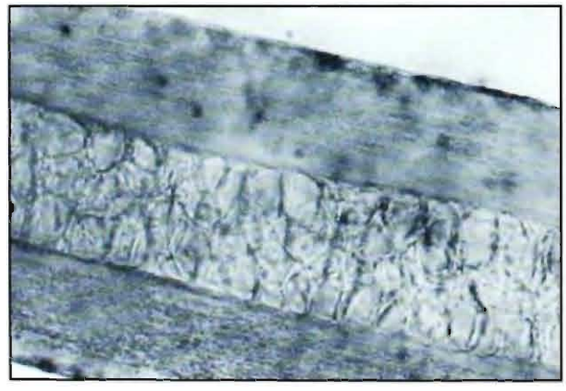
Pelage colour of Brown Bear



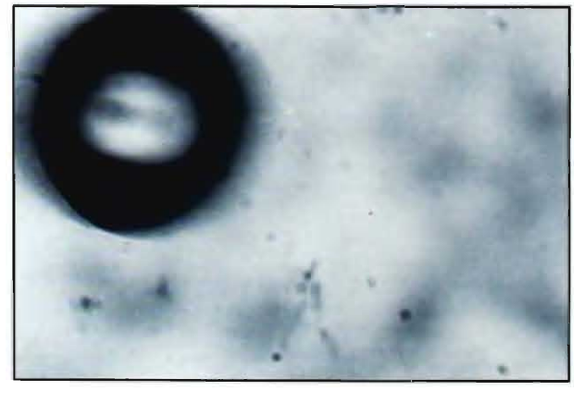
Cuticle (Shield)



Cuticle (Basal & Sub-shield)



Medulla



Cross Section

Microstructure of dorsal guard hair of Brown Bear, *Ursus arctos* Linnaeus

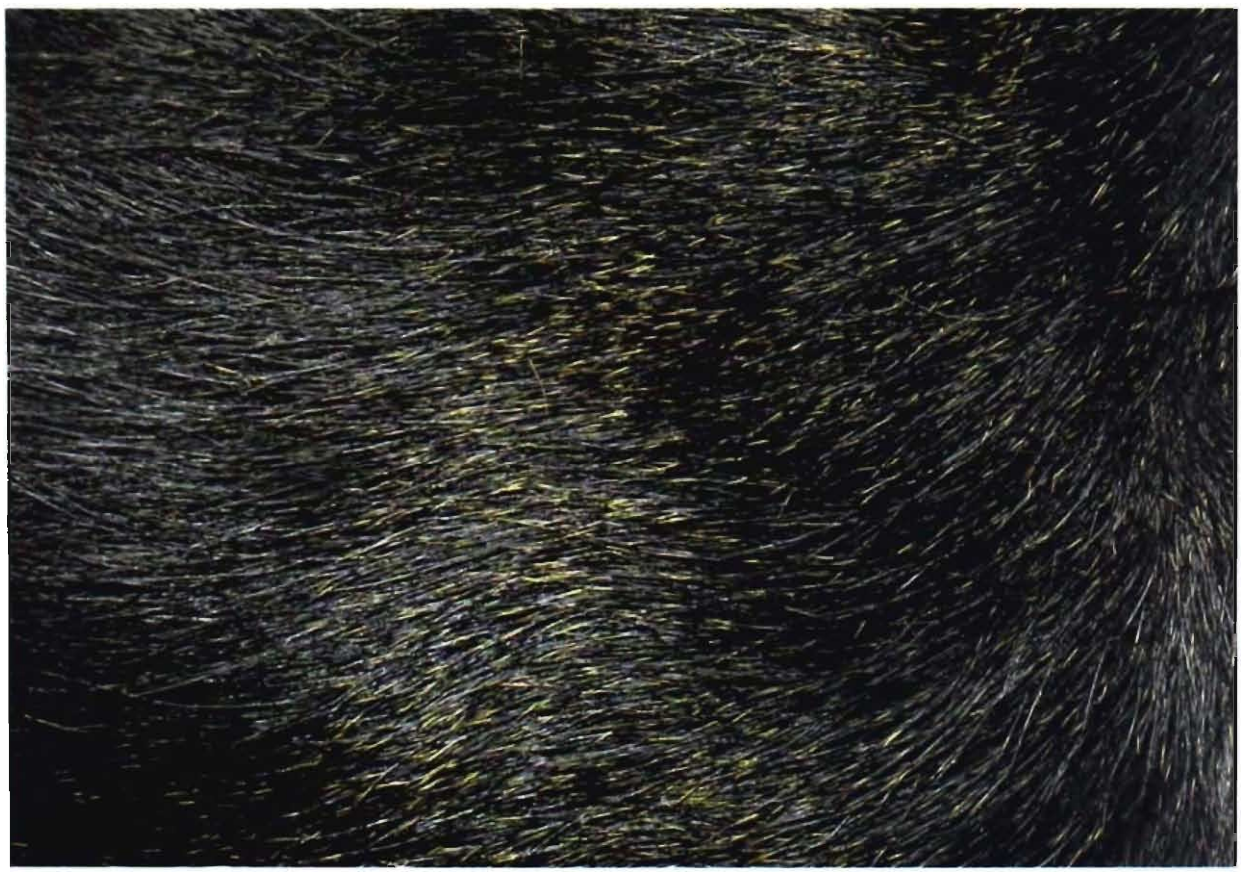
18. *Ursus thibetanus* Cuvier

Common name : Himalayan Black Bear

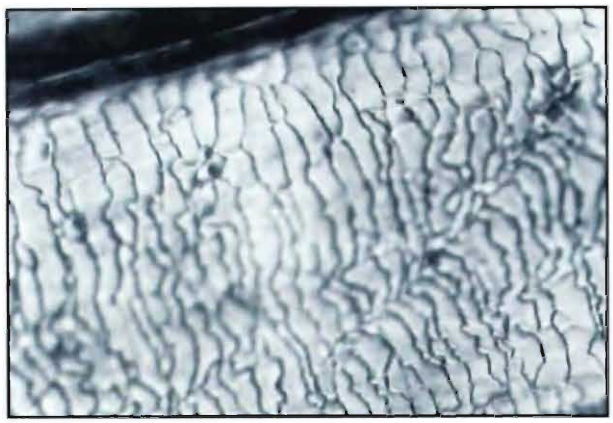
Coat colour : Black.

Distribution : Himalayas in India. *Extralimital* : From our limits eastwards to China and Japan, southwards to Myanmar and Malay countries and westwards to Baluchistan.

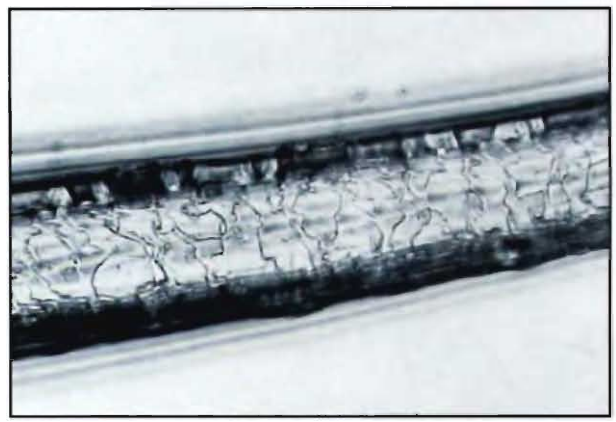
Characteristics of hair : *Colour* : Black; *Profile* : More or less straight, Shielded, A : Tapering; *Length* : 25-40 mm (34.42 ± 4.39); *No. of Band* : Nil; *Diameter* : A : 50-100µ (73.75 ± 9.15), S : 100-200 µ (136.66 ± 34.96), B : 70-150 µ (106.25 ± 26.42); *Scale type* : Imbricate-Crenate; *Scale Pattern* : B & Ssh : Irregular wave, S : Irregular mosaic; *Scale margin* : Crenate; *Scale margin distance* : Close; *Scale count/mm of hair length* : 450-600 µ (510 ± 20.05); *SS* : 30-50 µ (40 ± 6.32); *PD* : 2-10 µ (7 ± 1.58); *Medullary configuration* : Unbroken vacuolated; *Medullary index* : 0.29-0.32 (0.31 ± 0.01); *Cross Section* : Circular.



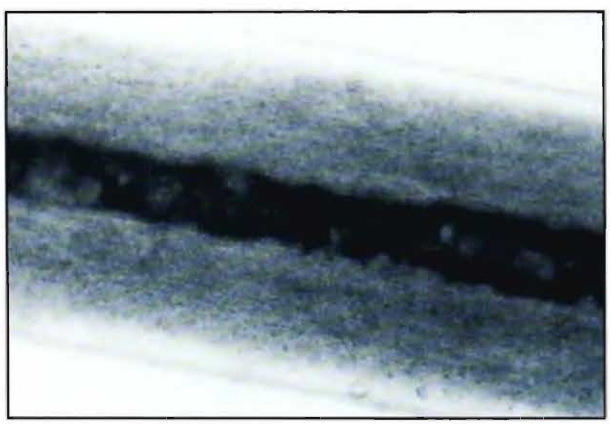
Pelage colour of Himalayan Black Bear



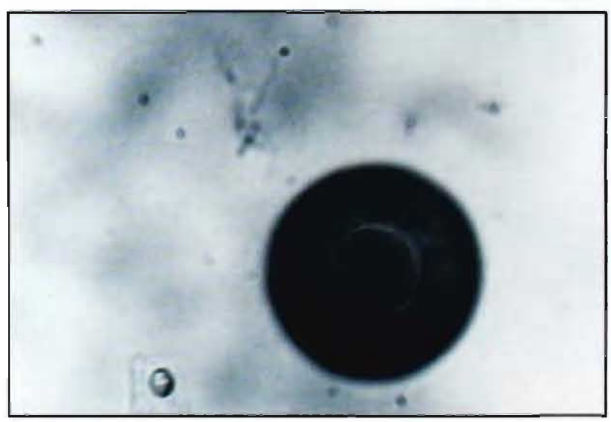
Cuticle (Basal & Sub-shield)



Cuticle (Shield)



Medulla



Cross Section

Microstructure of dorsal guard hair of Himalayan Black Bear, *Ursus thibetanus* Cuvier

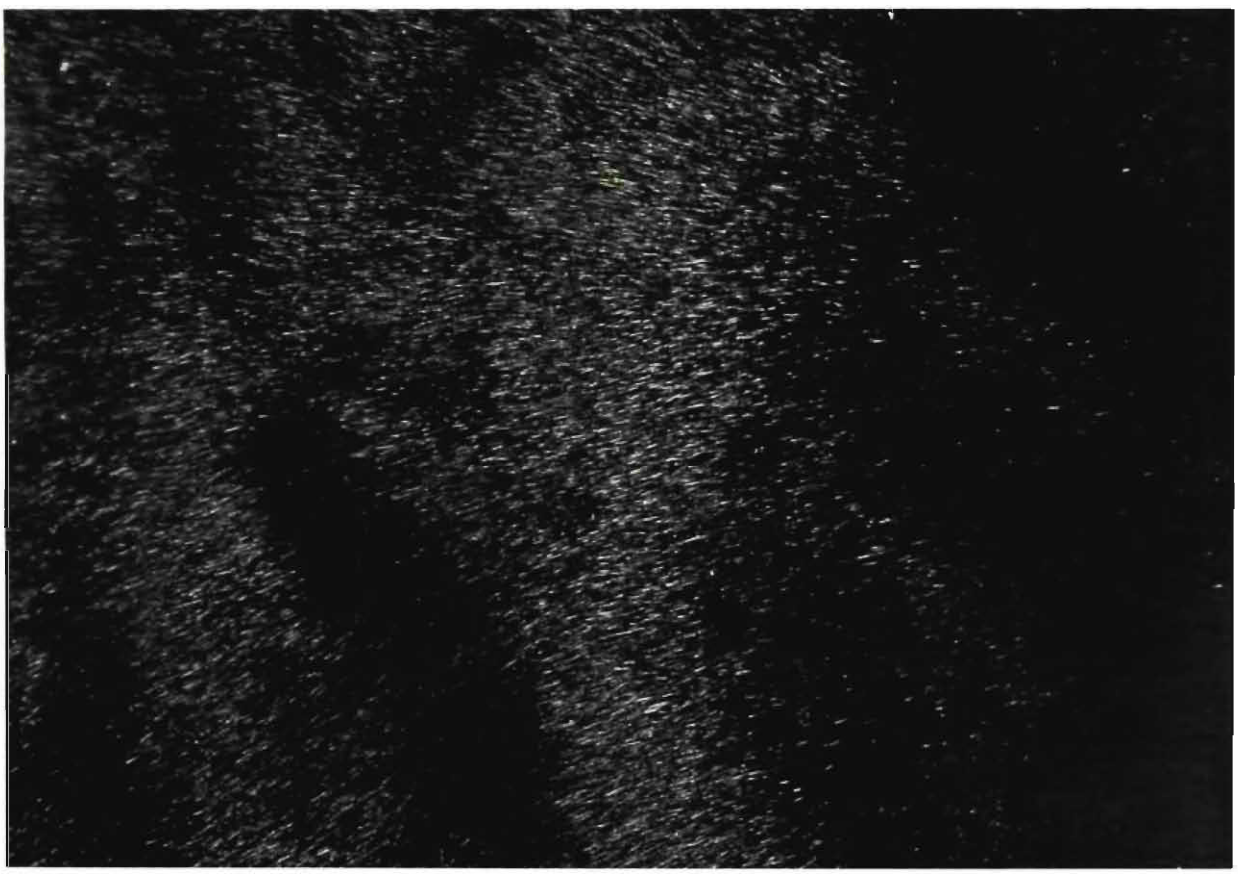
19. *Helarctos malayanus* (Raffles)

Common name : Malayan Sun Bear

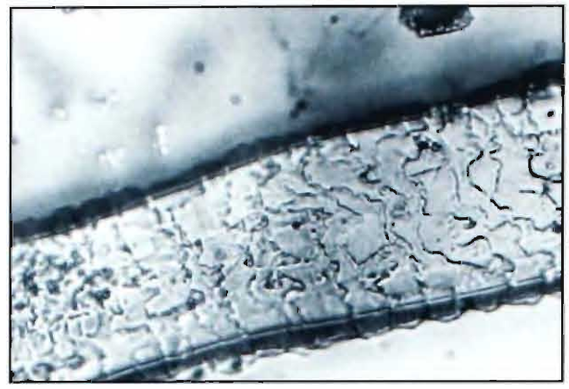
Coat colour : Black.

Distribution : Northeastern India. *Extralimital* : Myanmar eastwards to Vietnam and southern China and southeast to Malaysia and Indonesia.

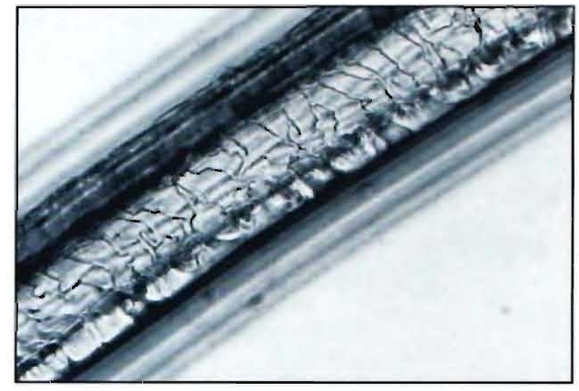
Characteristics of hair : *Colour* : Black; *Profile* : Unshield, almost curly; *Length* : 12-18 mm (15.5 ± 1.73); *No. of Band* : Nil; *Diameter* : A : 50-90 µ (62.5 ± 10.39), M : 90-100 µ (98.75 ± 3.3), B : 70-150 µ (70.25 ± 6.4); *Scale type* : Imbricate-Crenate; *Scale Pattern* : S & Ssh : Regular wave, B : Irregular mosaic; *Scale margin* : Crenate; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 95-120 (100 ± 0.25); *SS* : 30-70 µ (47 ± 13.46); *PD* : 10-20 µ (17 ± 2.58); *Medullary configuration* : Simple unbroken amorphous; *Medullary index* : 0.86-0.89 (0.87 ± 0.001); *Cross Section* : Circular.



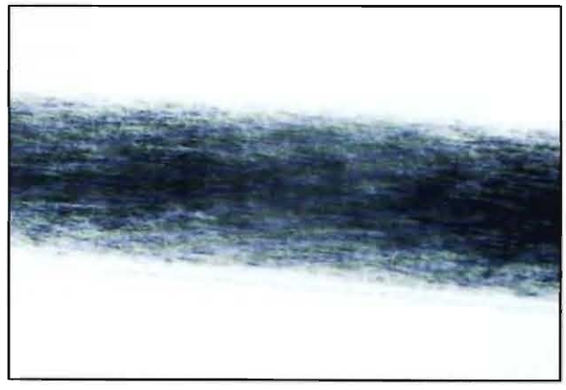
Pelage colour of Malayan Sun Bear



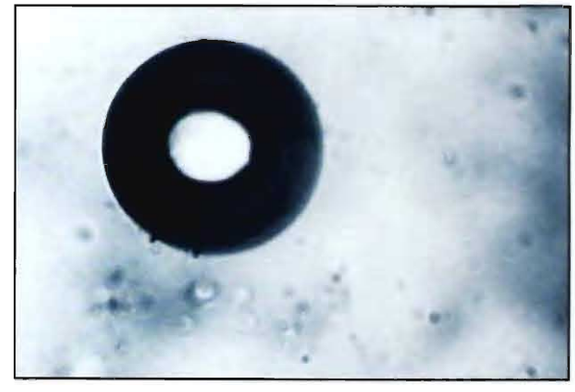
Cuticle (Shield & Sub-shield)



Cuticle (Basal)



Medulla



Cross Section

Microstructure of dorsal guard hair of Malayan Sun Bear, *Helarctos malayanus* (Raffles)

20. *Melursus ursinus* (Shaw)

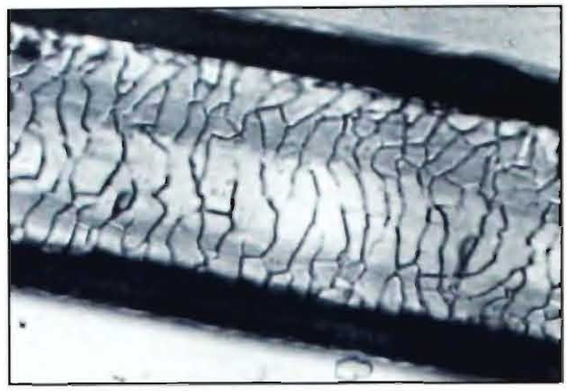
Common name : Sloth Bear

Coat colour : Black.

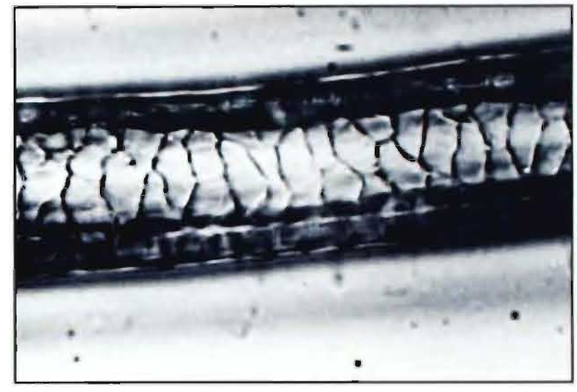
Distribution : Almost throughout India in suitable forested area; *Extralimital* : Sri Lanka.

Characteristics of hair : *Colour* : Black; *Profile* : More or less straight, shielded; *Length* : 59-73 mm (69.44 ± 3.02); *No. of Band* : Nil; *Diameter* : A : 100-170 µ (127.14 ± 26.57), S : 150-200 µ (170 ± 19.0), B : 100-160 µ (123.75 ± 19.07); *Scale type* : Imbricate-Smooth; *Scale Pattern* : B & Ssh : Regular wave, S : Regular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 280-410 (380 ± 20.25); *SS* : 30-60 µ (45 ± 10.25); *PD* : 3-10 µ (7 ± 2.58); *Medullary configuration* : Simple unbroken amorphous; *Medullary index* : 0.91-0.92 (0.91 ± 0.008); *Cross Section* : Oblong.

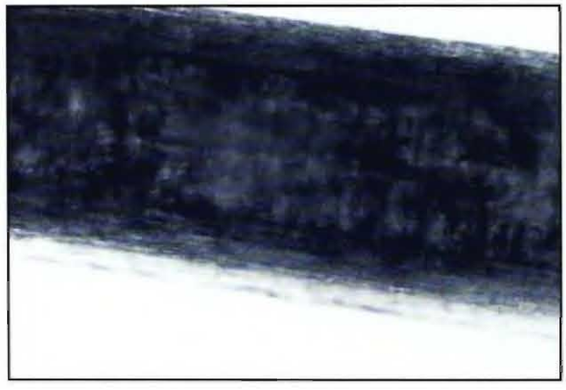
Pelage colour of Sloth Bear



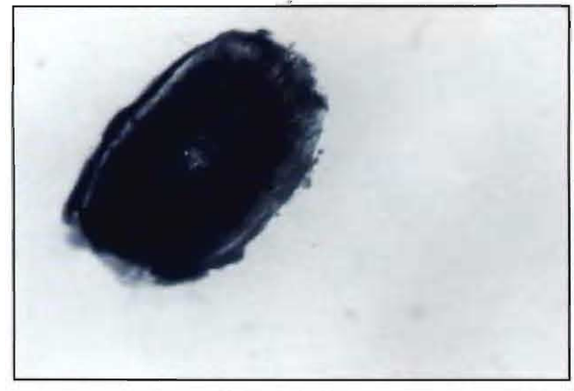
Cuticle (Basal & Sub-shield)



Cuticle (Shield)



Medulla



Cross Section

Microstructure of dorsal guard hair of Sloth Bear, *Melursus ursinus* (Shaw)

21. *Ailurus fulgens* Cuvier

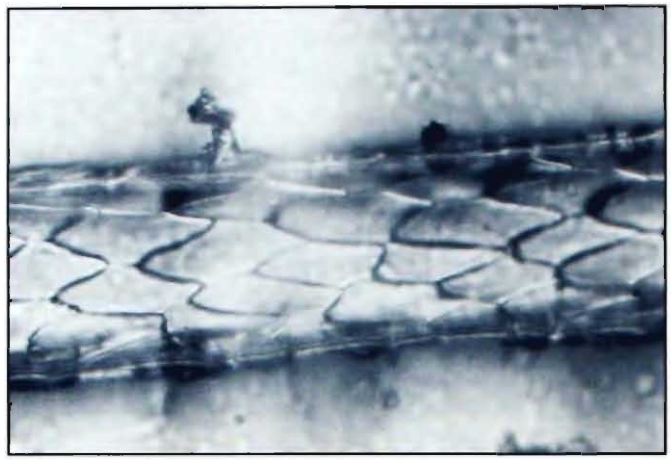
Common name : Red Panda

Coat colour : Body bright chestnut above and blackish below; legs black and soles hairy.

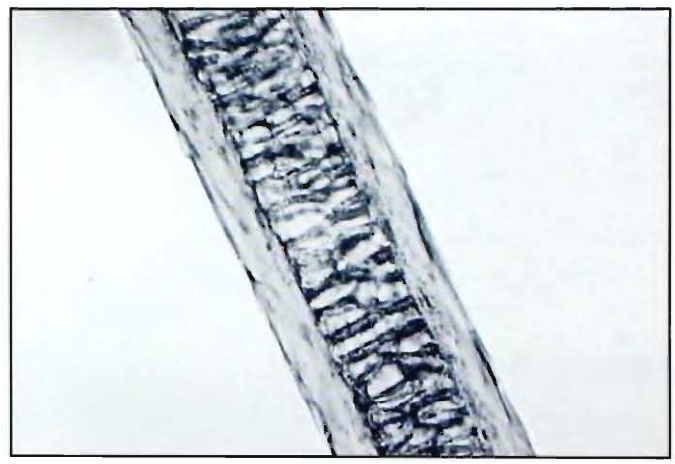
Distribution : Arunachal Pradesh, Sikkim and northern West Bengal. *Extralimital* : China, Myanmar, Nepal.

Characteristics of hair : *Colour* : B : Cinnamon or Fawn, S & A : Brunt Umber; *Profile* : Spatulate, Straight, Shielded; *Length* : 47-56 mm (50.4 ± 3.07); *No. of Band* : Nil; *Diameter* : B : 50-60 μ (54.5 ± 1.29), Ssh : 70-80 μ (76.3 ± 3.358), S : 110-130 μ (116.4 ± 2.449); *Scale type* : Petaloid; *Scale Pattern* : Diamond petal; *Scale margin* : Smooth; *Scale margin distance* : Distant; *Scale count/mm of hair length* : 498-535 (522); *SS* : 3.1-4.4 μ (4 ± 0.23); *PD* : 10-14.4 μ (13.12 ± 0.36); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.61-0.649 (0.63 ± 0.011); *Cross Section* : Circular.

Pelage colour of Red Panda



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Red Panda, *Ailurus fulgens* Cuvier

22. *Hyaena hyaena* (Linnaeus)

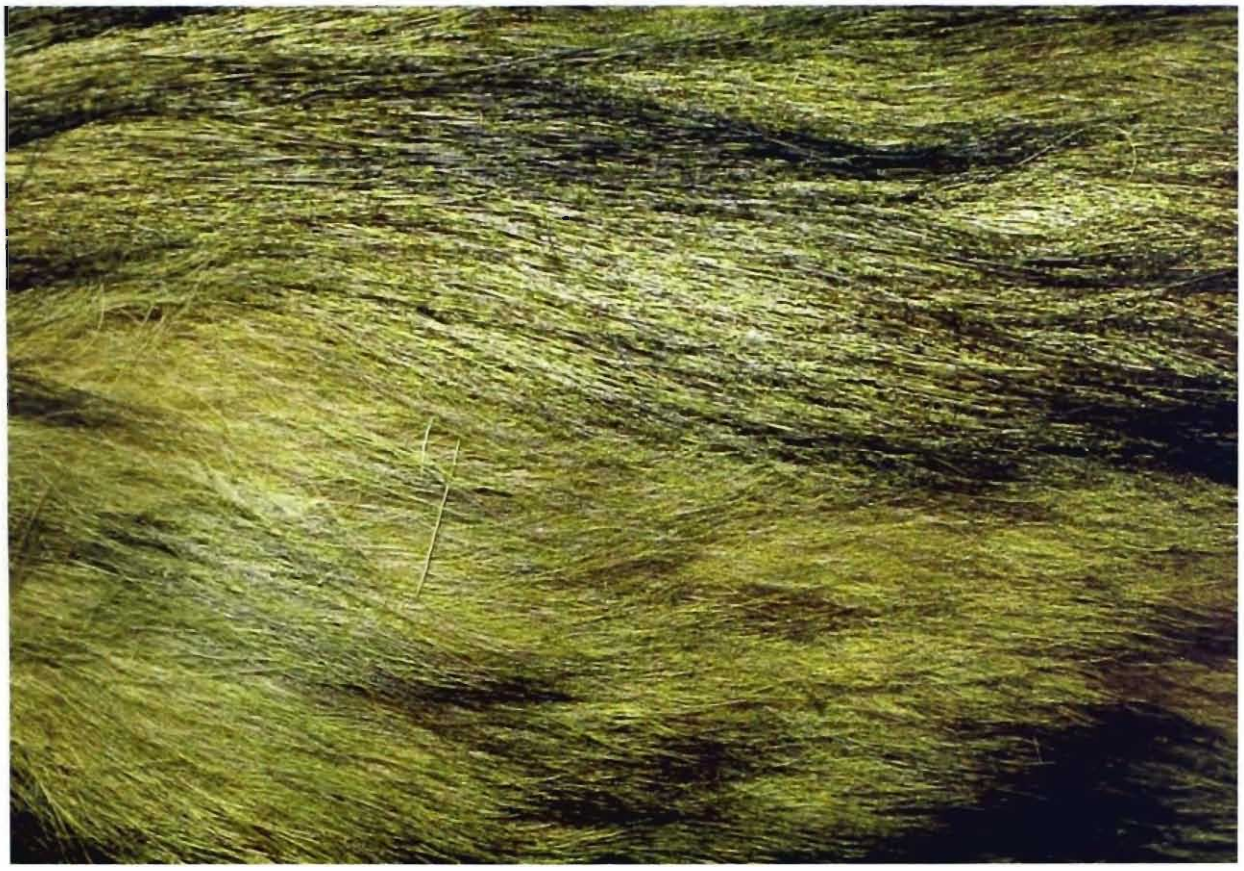
III. Family HYAENIDAE

Common name : Hyena

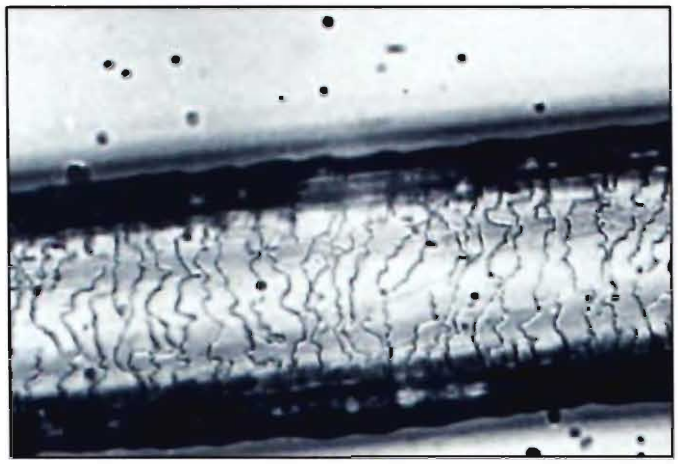
Coat colour : Coat-colour cream, buff, grey to pale brown; dark brown to black stripes on the body and legs; length of hairs of the mane ranges upto 200 mm, while those of the rest of the body about 70 mm;

Distribution : In India, from low lands of Jammu and Kashmir and Kumaon at north to Nilgiri Hills at south; west from Gujarat east upto West Bengal. *Extralimital* : Northern and eastern Africa, south to Tanzania; Asia Minor to Arabia, Iran, Transcaucasia and Turkmenia.

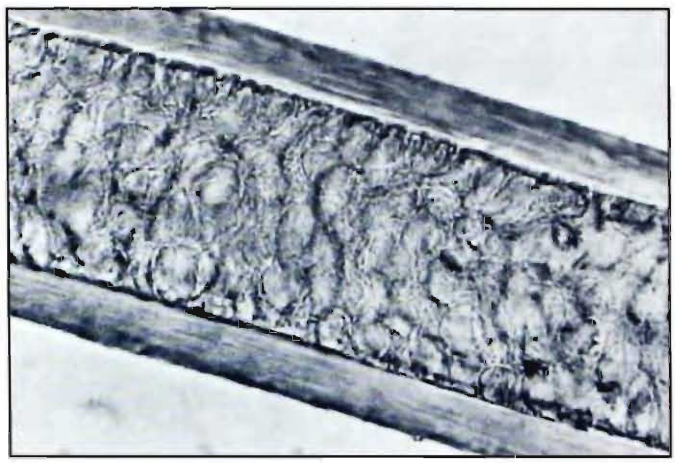
Characteristics of hair : *Colour* : A : Seal brown, paler towards root, B : Cream buff; *Profile* : Straight, banded, no shield; *Length* : 30-96 mm (60 ± 25.5); *No. of Band* : 2, rarely 3; *Diameter* : A : 30-80 μ (58 ± 15.36), Ssh : 70-170 μ (118 ± 32.49), B : 80-150 μ (113 ± 34.94); *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 175-335 (295); *SS* : 57.25-71.5 μ (64.26 ± 5.04); *PD* : 1.8-13.9 μ (10.75 ± 2.05); *Medullary configuration* : Simple unbroken cellular; *Medullary index* : 0.56-0.59 (0.57 ± 0.002); *Cross Section* : Almost circular.



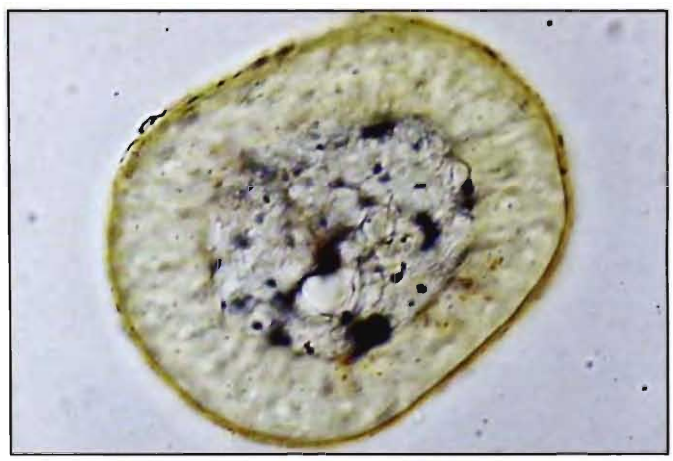
Pelage colour of Hyena



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Hyena, *Hyaena hyaena* (Linnaeus)

23. *Canis aureus* Linnaeus

IV. Family CANIDAE

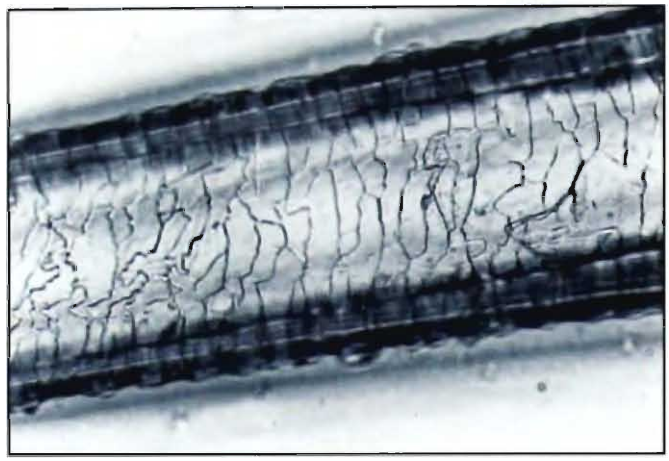
Common name : Asiatic Jackal

Coat colour : Coat colour, a mixture of black and white washed with buff.

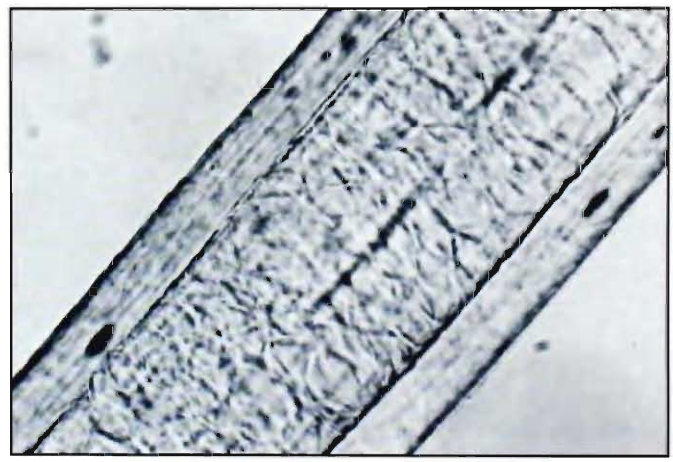
Distribution : Almost throughout the country. *Extralimital* : Afghanistan, central SW and south Asia, North and East Africa, SE Europe, Iran, Nigeria, Tangania, Thailand, Transcaucasus, Sri Lanka.

Characteristics of hair : Colour : Brunt umber usually with broad white or fawn coloured band at subshield, rarely posterior, basal region lighter; Profile : Narrowly spatulate, straight, shielded; Length : 24-71 mm (46.76 ± 13.14); No. of Band : 1 or rarely absent; Diameter : B : 40-90 µ (56.5 ± 13.52), Ssh : 40-90 µ (61 ± 16.4), S : 50-110 µ (76.5 ± 22.16); Scale type : Imbricate-Crenate; Scale Pattern : Irregular wave; Scale margin : Crenate; Scale margin distance : Intermediate; Scale count/mm of hair length : 165-215 (195); SS : 33-43 µ (37.5 ± 3.04); PD : 8-10 µ (8.45 ± 1.31); Medullary configuration : Vacuolated; Medullary index : 0.66-0.68 (0.67 ± 0.02) Cross Section : Circular.

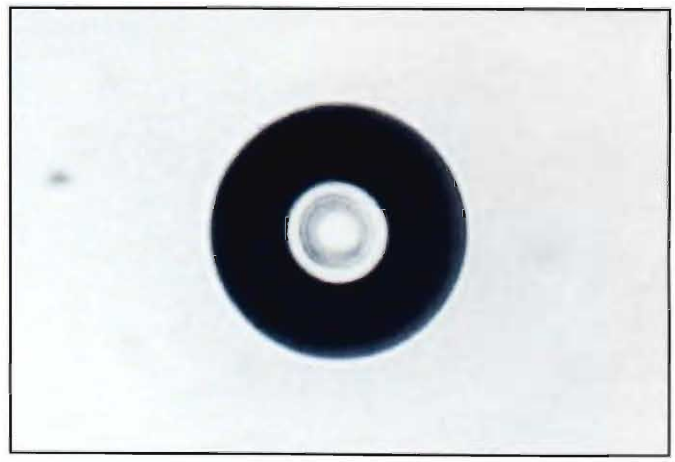
Pelage colour of Asiatic Jackal



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Asiatic Jackal, *Canis aureus* Linnaeus

24. *Canis lupus* Linnaeus

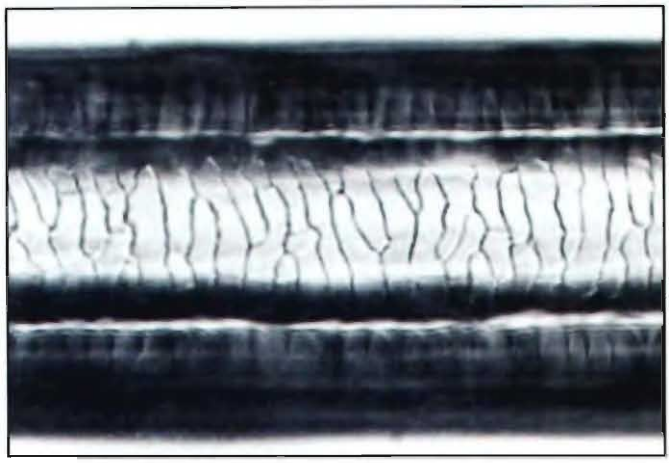
Common name : Wolf

Coat colour : Dorsal grayish fulvous or reddish, with a brown shade, sometimes mixed with black; face and limbs reddish.

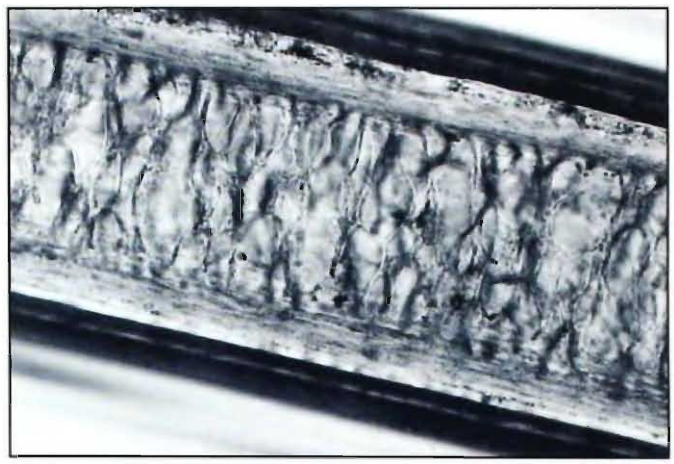
Distribution : Except extreme south, practically all over the country. *Extralimital* : Throughout the northern hemisphere, North America south to 20° N in Oaxaca (Mexico), Europe, Asia, including the Arabian Peninsula and Japan excluding Indo-China.

Characteristics of hair : *Colour* : Extreme basal white, B : brunt umber, M : cream buff, A : clove brown; *Profile* : Almost rod like with very long shield region and comparatively thin apical portion; *Length* : 105-110 mm (107 ± 1.4); *No. of Band* : 1, very broad cream buff band at the middle; *Diameter* : B : 60-90 µ (74 ± 10.56), M : 90-140 µ (116 ± 10.32), A : 60-90 µ (72 ± 14.69); *Scale type* : Imbricate-Crenate; *Scale Pattern* : Irregular wave; *Scale margin* : Smooth with number of notches; *Scale margin distance* : Intermediate; *Scale count/mm of hair length* : 234-332 (252); *SS* : 10-33 µ (26.7 ± 7.74) µ; *PD* : 8-16.5 µ (10.5 ± 2.34); *Medullary configuration* : Vacuolated; *Medullary index* : 0.53-0.58 (0.55 ± 0.018); *Cross Section* : Circular.

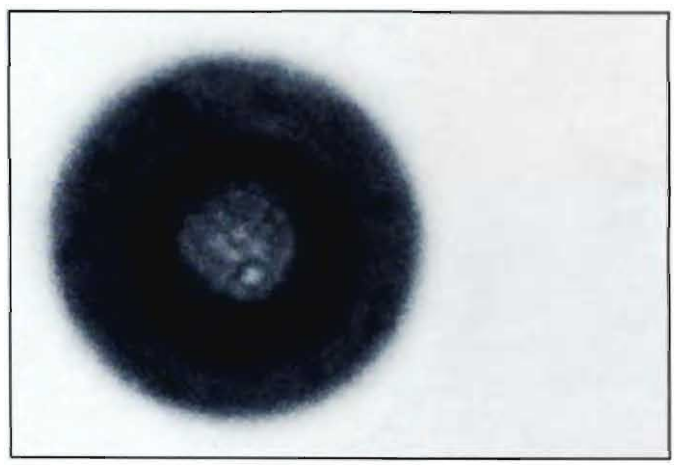
Pelage colour of Wolf



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Wolf, *Canis lupus* Linnaeus

25. *Vulpes vulpes* (Linnaeus)

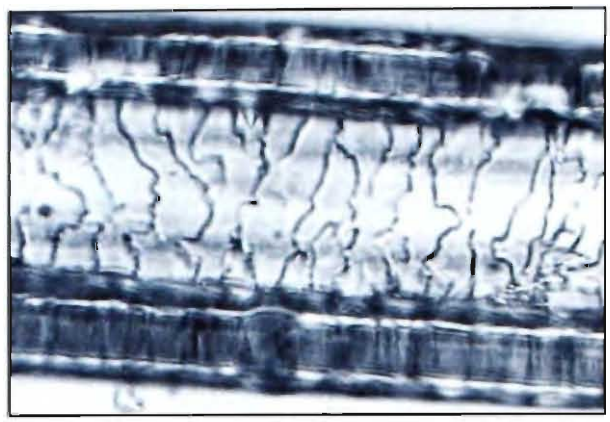
Common name : Common Red Fox

Coat colour : Colour greatly variable from bright yellow, silvery, gray but rich in reddish tinge.

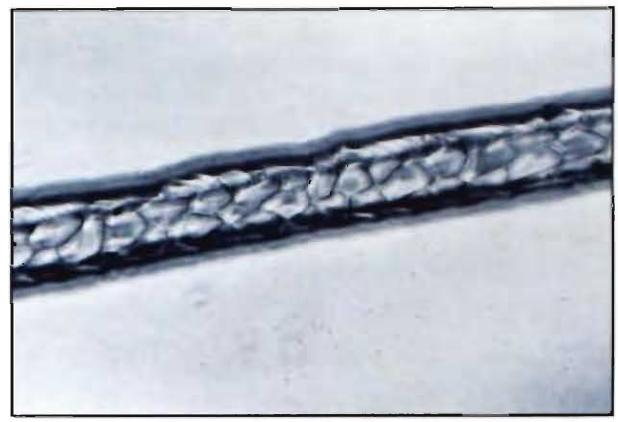
Distribution : In India, Gujarat, Himachal Pradesh, Kashmir, Punjab, Rajasthan, Sikkim, Uttar Pradesh. *Extralimital* : Throughout Palaearctic region, North America, Australia, Continental Asia, Europe, Indo-China, Japan,

Characteristics of hair : *Colour* : Brunt umber or Prout's brown with or without broad cream buff or lighter band at shield, base white or paler; *Profile* : Spatulate, Straight, Shielded; *Length* : 31-52 mm (42.7 ± 6.659); *No. of Band* : 1 or none; *Diameter* : B : 30-60 μ (42 ± 8.32), Ssh : 40-50 μ (44.5 ± 4.94), S : 50-90 μ (64.66 ± 3.196); *Scale type* : Imbricate-Crenate, A : Imbricate-elongate or coronal-dentate; *Scale Pattern* : B : Irregular wave, M : Irregular mosaic, A : Pectinate; *Scale margin* : Crenate, A : Smooth; *Scale margin distance* : Intermediate, A : Distant; *Scale count/mm of hair length* : B : 103-163 (121), Ssh : 116-148 (124), S : 71-117 (83), A : (Mosaic) 128-162 (142), A : (Pectinate) 196-366 (344); *SS* : B : 8.75-12.5 μ (11.03 ± 1.35), Ssh : 9.4-0.15 μ (12.12 ± 1.55), S : 12.5-16.25 μ (14.5 ± 1.27); *PD* : B : 3.1-6.25 μ (4.62 ± 1.02), Ssh : 3.7-9.4 μ (5.13 ± 1.39), S : 3.75 7.5 μ (5.68 ± 0.85); *Medullary configuration* : Vacuolated; *Medullary index* : 0.72-0.73 (0.722 ± 0.004); *Cross Section* : Circular.

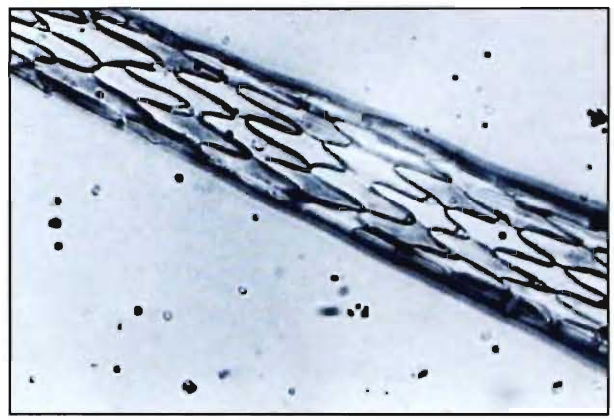
Pelage colour of Common Red Fox



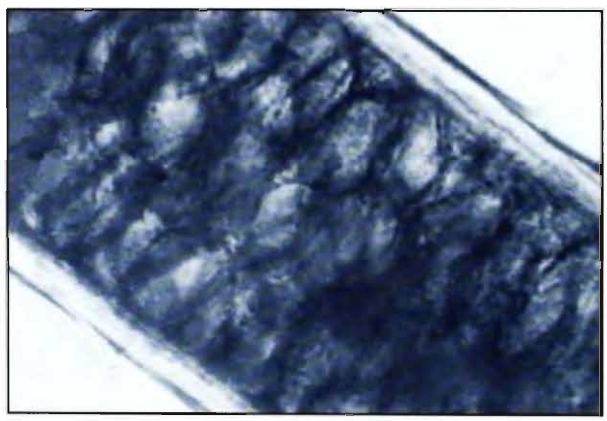
Cuticle (Basal)



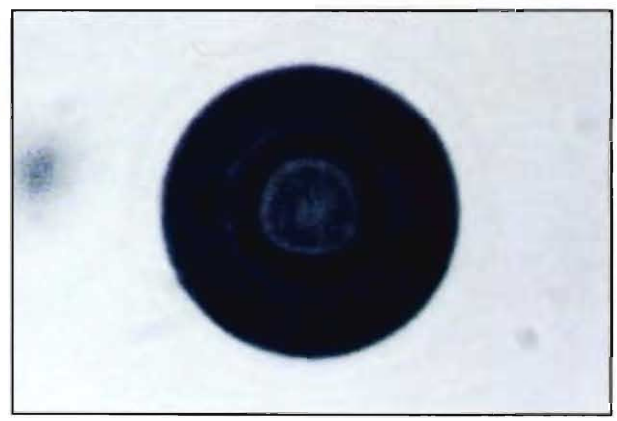
Cuticle (Middle)



Cuticle (Apical)



Medulla



Cross Section

Microstructure of dorsal guard hair of Common Red Fox, *Vulpes vulpes* (Linnaeus)

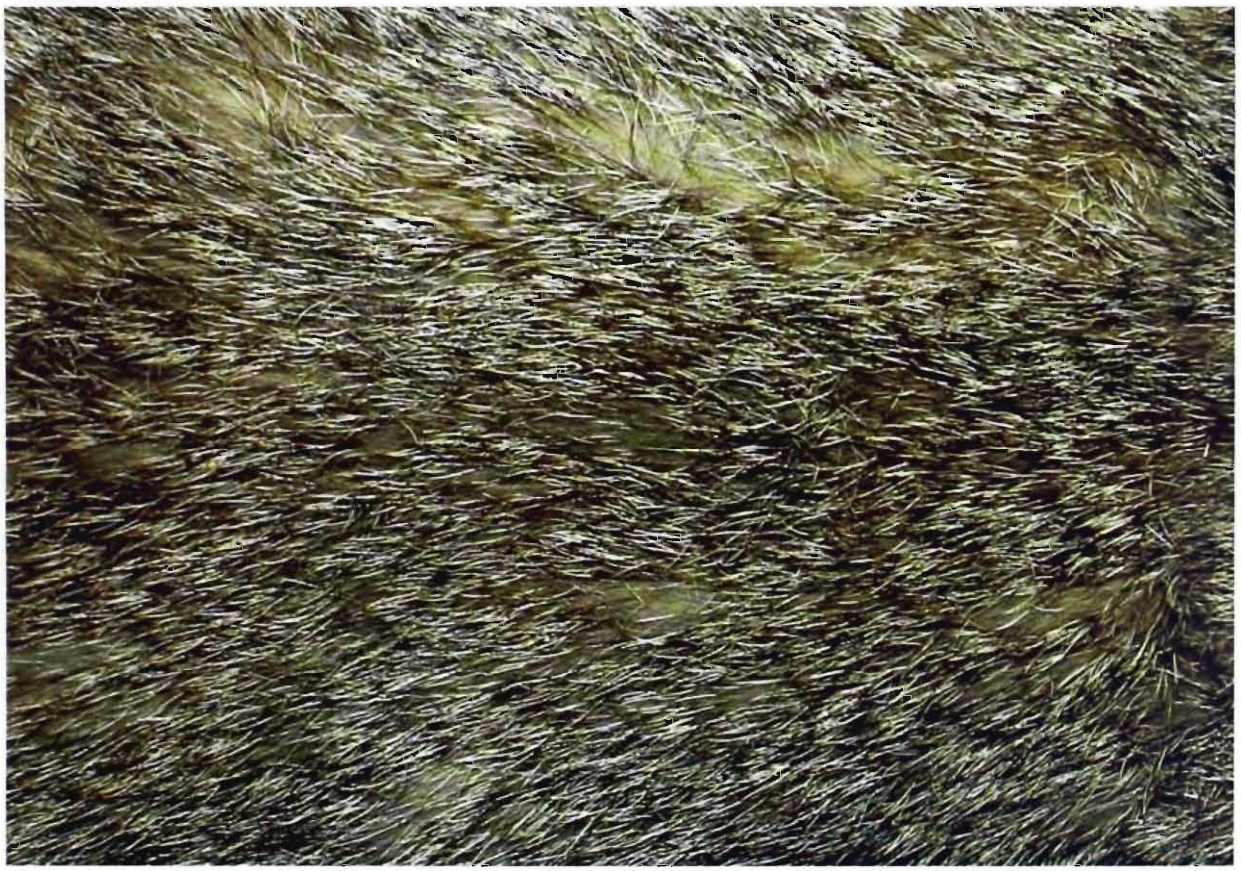
26. *Vulpes bengalensis* (Shaw)

Common name : Indian Fox

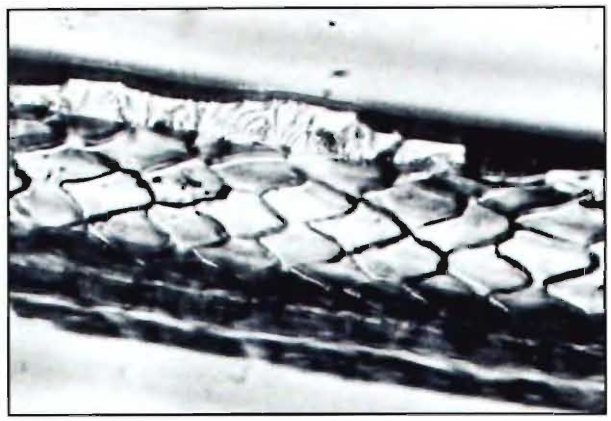
Coat colour : Colour gray, distinctive in the black tip to its tail.

Distribution : Throughout the country. *Extralimital* : Bangladesh, Nepal, Pakistan.

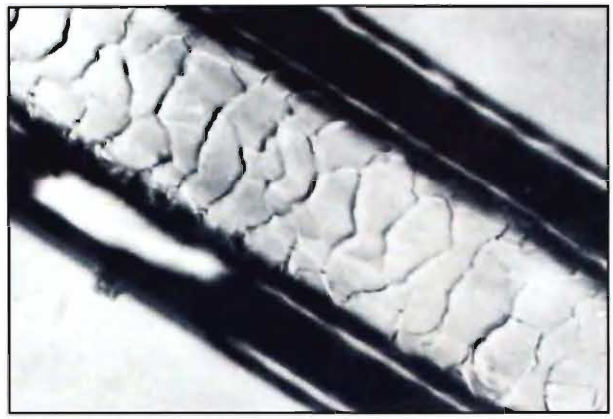
Characteristics of hair : *Colour* : Brunt umber, paler to white from subshield to basal region; *Profile* : Spatulate, Straight, Shielded; *Length* : 21-31 mm (26.6 ± 2.9); *No. of Band* : 1 (white) at shield region; *Diameter* : B : 40-60 µ (50 ± 6.3), Ssh : 60, S : 80-100 µ (92 ± 7.4); *Scale type* : Imbricate-flattened, A : Coronal-dentate; *Scale Pattern* : B & M : Irregular-wave Mosaic, A : Diamond petal; *Scale margin* : Almost smooth with few notches; *Scale margin distance* : Distant, B : Intermediate; *Scale count/mm of hair length* : B : 231-387 (287), Ssh : 126-196 (172), S : 122-158 (138); *SS* : 10-13 µ (11.6 ± 1.39); *PD* : 24-32 µ (26.2 ± 2.2); *Medullary configuration* : Vacuolated; *Medullary index* : 0.80-0.83 (0.81 ± 0.012); *Cross Section* : Circular.



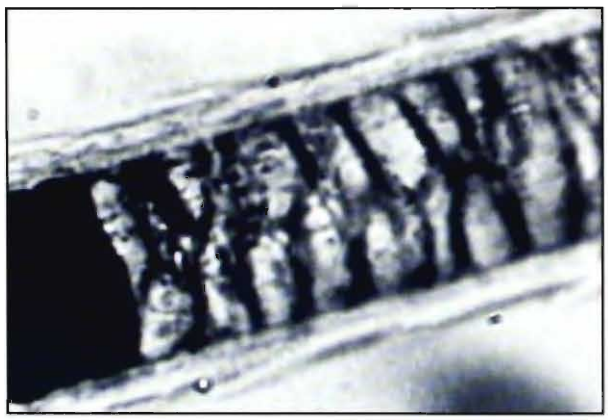
Pelage colour of Indian Fox



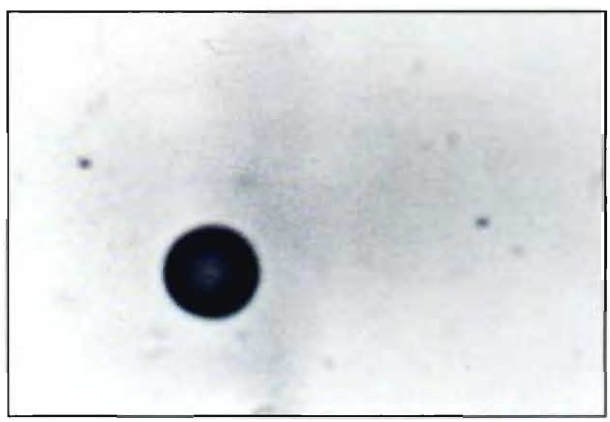
Cuticle (Apical)



Cuticle (Basal & Middle)



Medulla



Cross Section

Microstructure of dorsal guard hair of Indian Fox, *Vulpes bengalensis* (Shaw)

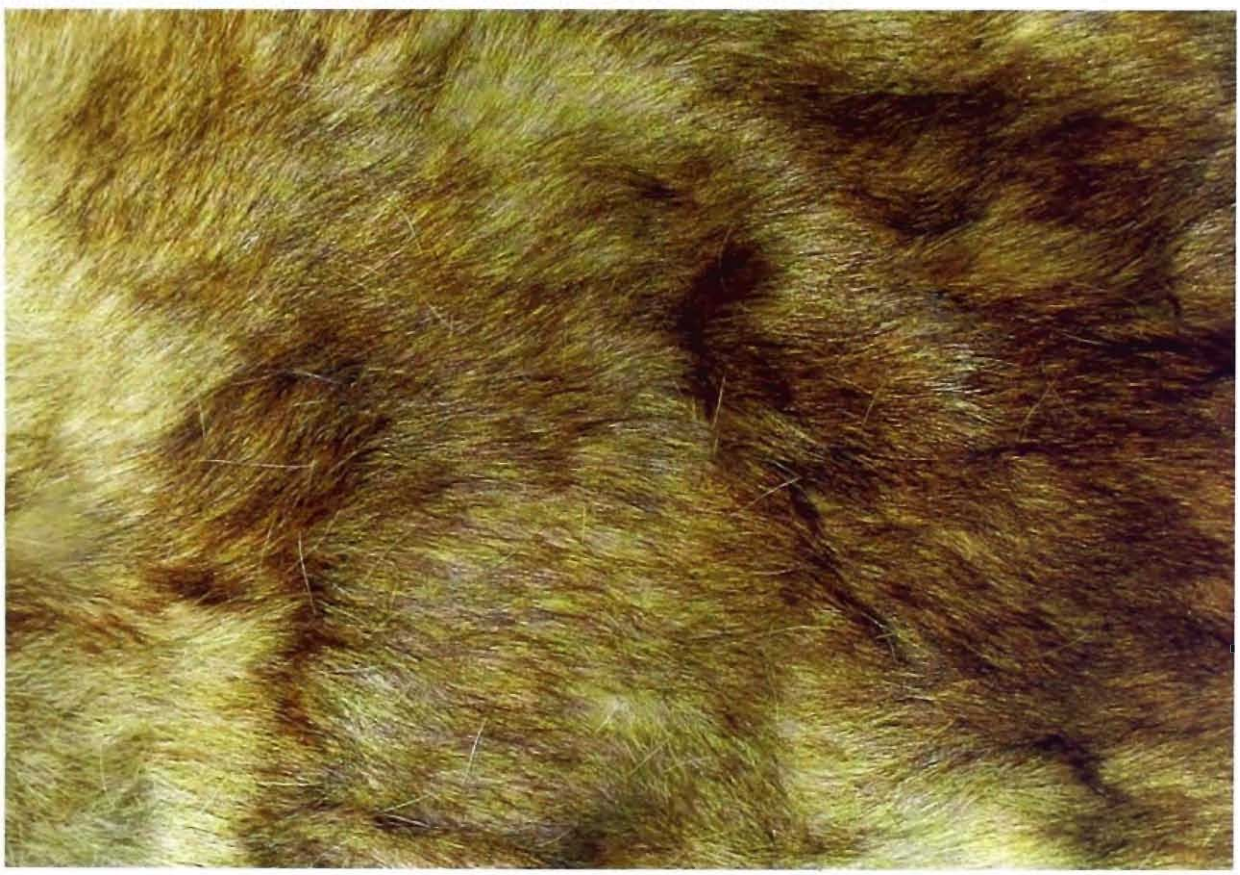
27. *Cuon alpinus* (Pallas)

Common name : Dhole

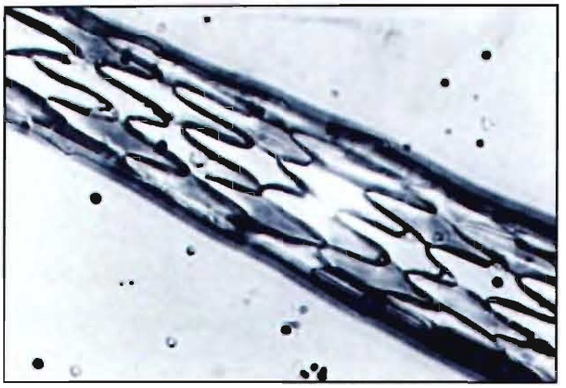
Coat colour : Distinctive reddish coat varies in tone with season and locality, tail tip blakish.

Distribution : In India, south of river Ganges, peninsula from Coorg and Nilgiri Hills northwards to Kashmir, Sikkim, Darjeeling district of West Bengal, Uttar Pradesh and NE India. *Extralimital* : Bhutan, China, Indo-China, Indonesia, Korea, Malaysia, Manchuria, Mangolia, Nepal, Pakistan, Russia (Ussuri region, Siberia), Tibet.

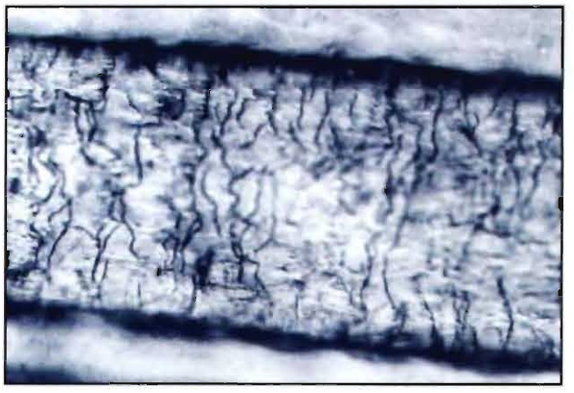
Characteristics of hair : *Colour* : Brunt umber with a very broad fawn coloured band just below the tip, basal sometimes whitish; *Profile* : Almost rod like; *Length* : 35-55 mm (44.2 ± 3.6); *No. of Band* : 1, colour of bands towards apical side is darker and basal is lighter, length of band is extremely variable; *Diameter* : B : 60-100 μ (80 ± 12.64), M : 60-120 μ (84 ± 19), A : 60-100 μ (73 ± 11.87); *Scale type* : B & M : Imbricate-Crenate, A : Coronal-dentate; *Scale Pattern* : B & M : Irregular wave, A : Pectinate; *Scale margin* : B & M : Crenate; A : Almost smooth; *Scale margin distance* : B & M : Intermediate, A : Distant; *Scale count/mm of hair length* : M & B : 103-151 (136), A : 240-298 (276); *SS* : M & B : 32-55 μ (43 ± 3.7), A : 7-10 μ (7.8 ± 1.2); *PD* : M & B : 7-18 μ (12.4 ± 3.8), A : 39-49 μ (42.8 ± 2.77); *Medullary configuration* : Vacuolated; *Medullary index* : 0.58-0.60 (0.59 ± 0.02); *Cross Section* : Circular.



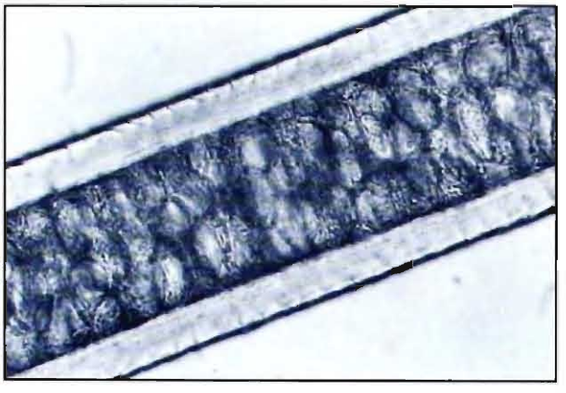
Pelage colour of Dhole



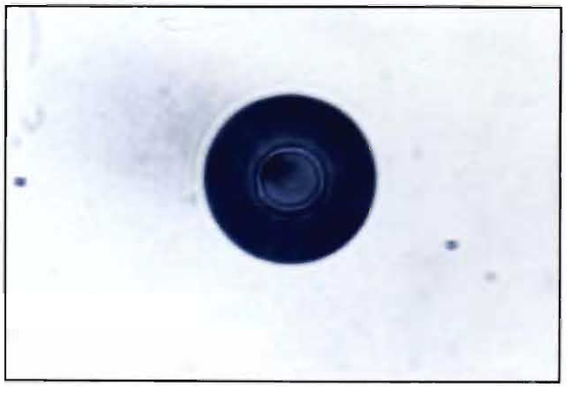
Cuticle (Apical)



Cuticle (Basal & Middle)



Medulla



Cross Section

Microstructure of dorsal guard hair of Dhole, *Cuon alpinus* (Pallas)

28. *Herpestes edwardsi* (E.Geoffroy Saint-Hilaire)

V. Family HERPESTIDAE

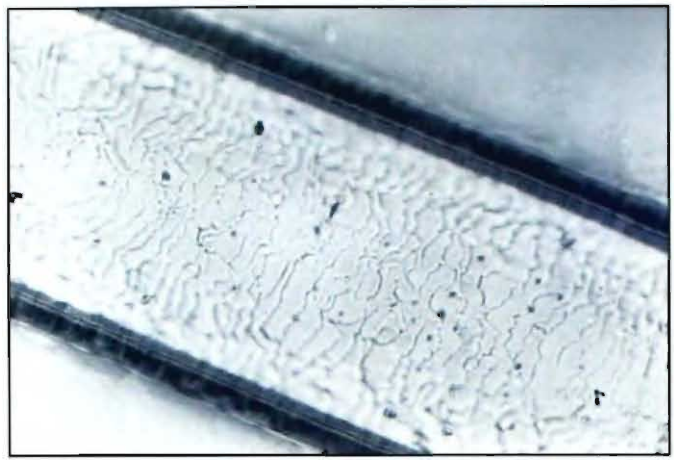
Common name : Indian Grey Mongoose

Coat colour : A tawny yellowish gray mongoose, with no stripes on the sides of neck; with a trailing white-tipped tail.

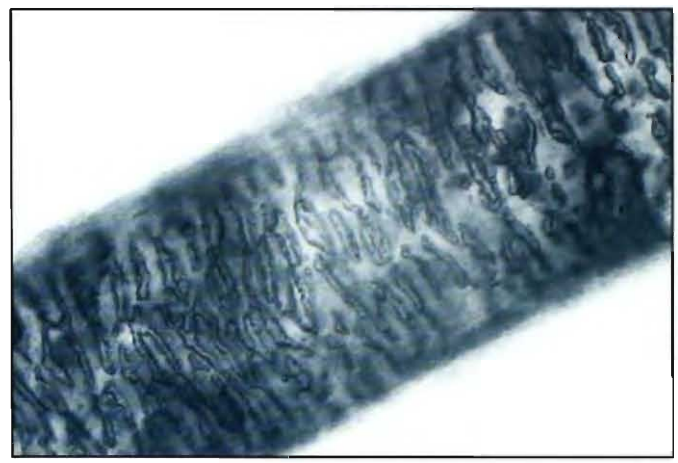
Distribution : Throughout India in suitable habitat. *Extralimital* : Afghanistan, Bahrain, Indonesia, Iran, Japan, Kuwait, Malaysia, Nepal, Pakistan, Saudi Arabia, Sri Lanka.

Characteristics of hair : *Colour* : Alternately banded with cream buff and clove brown, tip dark, sometimes overall ferrugineous; *Profile* : Straight, Unshield, Banded; *Length* : 20-31 mm (25.61 ± 3.34); *No. of Band* : 5-7, 80-85% hairs with 7 bands; *Diameter* : A : 50-90 µ (70 ± 12.4), M : 70-100 µ (90 ± 8.17), B : 50-90 µ (60 ± 5.4); *Scale Type* : Imbricate; *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Near; *Scale count/mm of hair length* : 180-225 (220); *SS* : 20-40 µ (30 ± 4.58); *PD* : 2-7 µ (5 ± 0.91); *Medullary configuration* : Unbroken with cortical intrusion; *Medullary index* : 0.81-0.83 (0.82 ± 0.003); *Cross Section* : Oblong.

Pelage colour of Indian Grey Mongoose



Cuticle



Medulla

Cross Section

Microstructure of dorsal guard hair of Indian Grey Mongoose, *Herpestes edwardsi* (E.Geoffroy Saint-Hilaire)

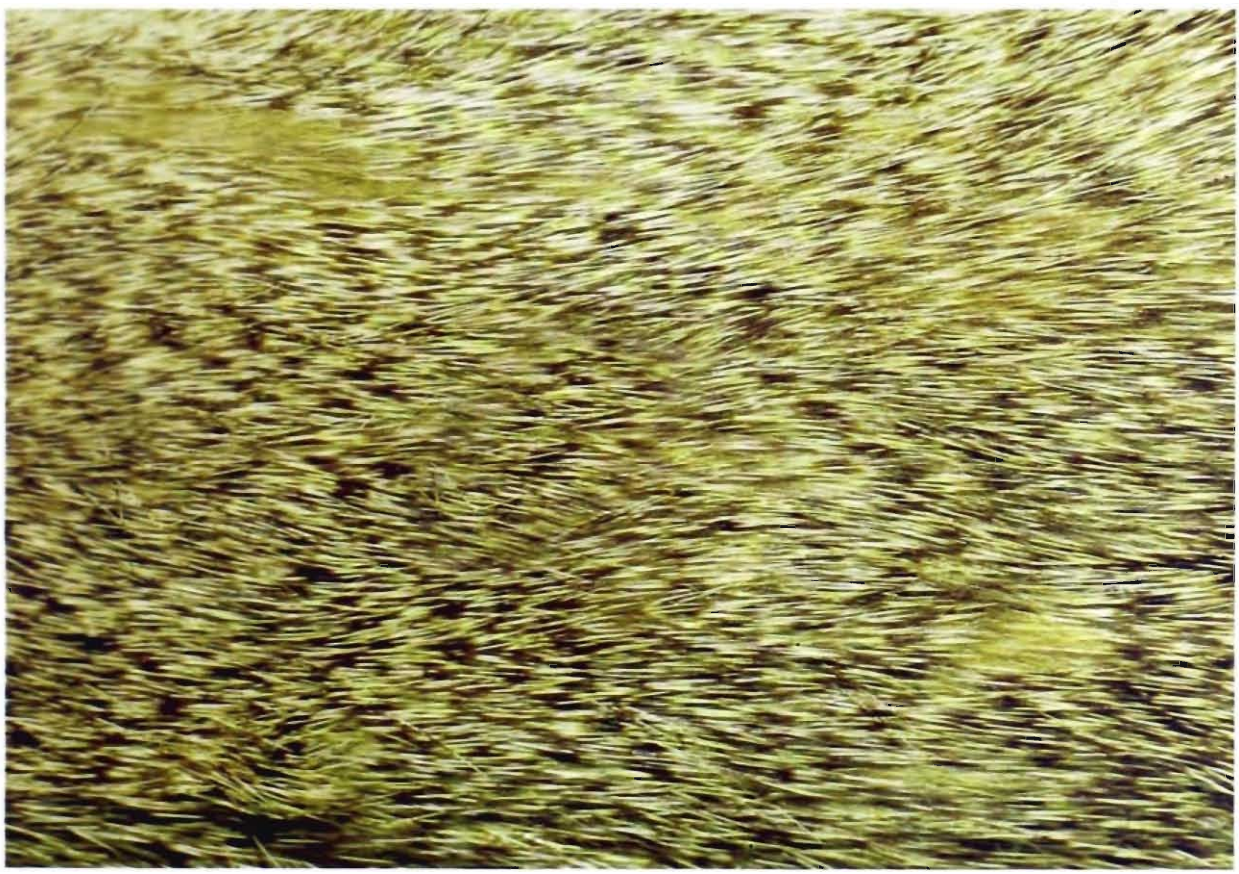
29. *Herpestes javanicus* (E.Geoffroy Saint-Hilaire)

Common name : Small Indian Mongoose

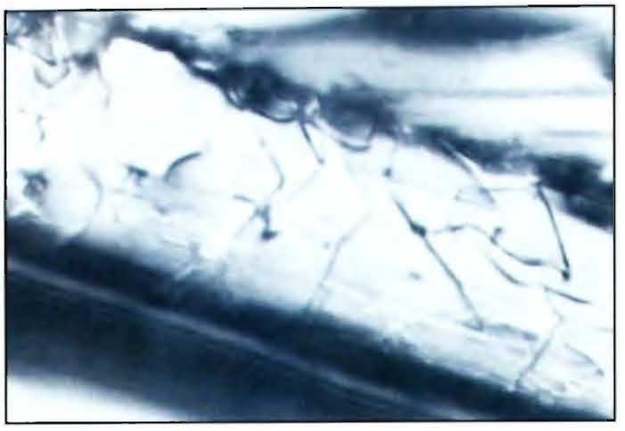
Coat colour : Dark olive brown in colour, minutely speckled with gold.

Distribution : From Jammu and Kashmir at north to Andhra Pradesh at south and west from Gujarat east upto NE states. *Extralimital* : Afghanistan, Bangladesh, Bhutan, Cambodia, China, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Thailand, Vietnam, and introduced in Cuba, Fiji Isls., Hawaiian Isls., Jamaica, Japan, Puerto Rico, Surinam, Surinam, West Indies and many other tropical regions.

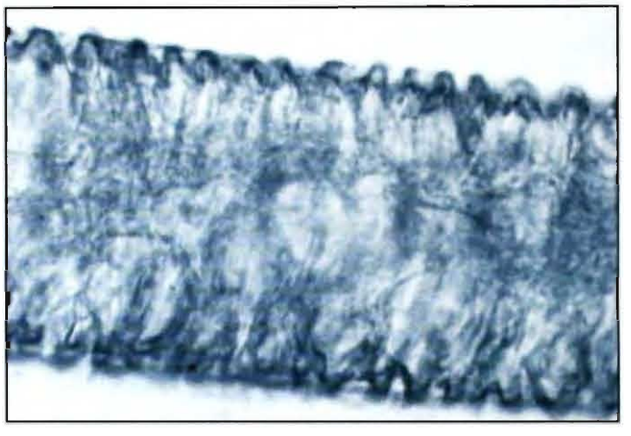
Characteristics of hair : *Colour* : Alternately banded with Clove brown and Buff with dark tip, geographical variation evident; *Profile* : Straight, Unshield, Banded; *Length* : 13-18 mm (14.83 ± 1.76); *No. of Band* : 5-7, 78-81% hairs with 5 bands; *Diameter* : A : 25-50 µ (41.66 ± 5.23), M : 50-100 µ (79.16 ± 9.19); B : 50-75 µ (62.5 ± 4.5); *Scale Type* : Imbricate; *Scale Pattern* : Flattened irregular mosaic; *Scale margin* : Smooth; *Scale margin distance* : Near; *Scale count/mm of hair length* : 95-120 (104); *SS* : 10-20 µ (16 ± 3.06); *PD* : 7-10 µ (8.31 ± 0.08); *Medullary configuration* : Unbroken with cortical intrusion; *Medullary index* : 0.88-0.90 (0.885 ± 0.0067); *Cross Section* : Ovate.



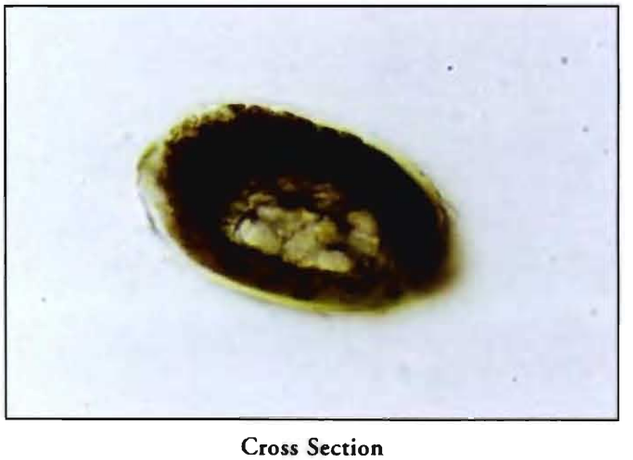
Pelage colour of Small Indian Mongoose



Cuticle



Medulla



Cross Section

Microstructure of dorsal guard hair of Small Indian Mongoose, *Herpestes javanicus* (E.Geoffroy Saint-Hilaire)

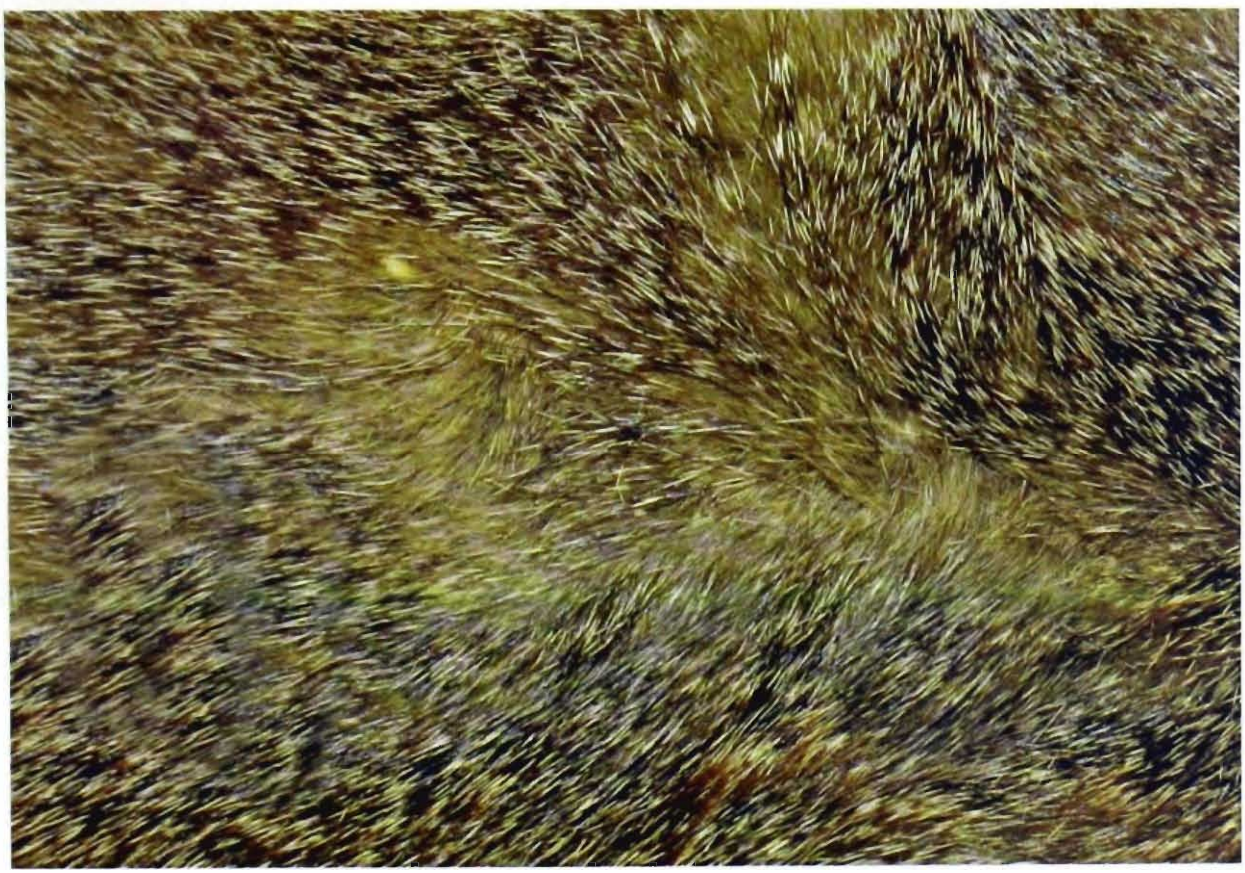
30. *Herpestes smithi* Gray

Common name : Ruddy Mongoose

Coat colour : Colour tawny yellowish grey with black tipped tail.

Distribution : In India, Rajasthan east to West Bengal, southwards through Eastern and Western Ghats. *Extralimital* : Sri Lanka.

Characteristics of hair : *Colour* : Alternately banded with cream and clove brown, tip dark; *Profile* : Straight, Unshield, Banded; *Length* : 32-35 mm (34 ± 0.26); *No. of Band* : 7-9, 80-85% hairs with 9 bands; *Diameter* : A : 50-70 µ (60 ± 5.89), M : 50-100 µ (80 ± 12.79), B : 50-75 µ (70 ± 2.25); *Scale Type* : Imbricate; *Scale Pattern* : Irregular wave; *Scale margin* : Crenate; *Scale margin distance* : Near; *Scale count/mm of hair length* : 152-198 (166); *SS* : 20-50 µ (30 ± 5.01); *PD* : 3-10 µ (7 ± 2.89); *Medullary configuration* : Unbroken cellular; *Medullary index* : 0.6-0.62 (0.617 ± 0.008); *Cross Section* : Ovate.



Pelage colour of Ruddy Mongoose

Name of species	Profile	Colour	No. of band	Length (mm)	Diameter (μ)	Scale count/mm of hair length
V. Family : Herpestidae						
Herpestes edwardsi	Straight Unshield Banded	Alternately banded with cream buff and clove brown; tip dark; sometimes overall ferrugineous	5-7, 80-85% hairs with 7 bands	20-31 (25.61± 3.34)	A: 50-90 (70±12.4) M: 70-100 (90±8.17) B: 50-90 (60±5.4)	180-225 (220)
Herpestes javanicus	Straight Unshield Banded	Alternately banded with clove brown and buff with dark tip; geographical variation evident	5-7 78-81% hairs with 5 bands	13-18 (14.83± 1.76)	A: 25-50 (41.66±5.23) M: 50-100 (79.16±9.19) B: 50-75 (62.5±4.5)	95-120 (104)
Herpestes smithi	Straight Unshield Banded	Alternately banded with cream and clove brown, tip dark	7-9 80-85% hairs with 9 bands	32-35 (34±0.26)	A: 50-70 (60±5.89) M: 50-100 (80±12.79) B: 50-75 (70±2.25)	152-198 (166)
Herpestes palustris	Straight Unshield Banded	Alternately banded with ochraceous buff and Prout's brown with dark tip	5-7 90-96% hairs with 5 bands	14-25 (18.5± 3.45)	A: 25-50 (40.83±6.31) M: 50-100 (80±7.64) B: 50-70 (58.33±4.78)	148-200 (160)
Herpestes urva	Straight Unshield Banded	Alternately banded with pale cinnamon & dusky iron grey, tip dark	3-4 90-95% hairs 4 banded	48-52 (50.16 ±1.33)	A: 50-75 (56.16±1.33) M: 100 B: 50-75 (66.83±6.52)	200-240 (222)
VI. Family : Viverridae						
Viverricula indica	Spatulate Straight Shielded Banded	Claret brown with buff band and shield	1	20-29 (23.83 ±2.12)	100-150 (120±10.6)	372-418 (400)
Paguma larvata	Spatulate Straight or little wavy Shielded Banded	Claret brown with lighter basal, dark apical and single broad buff band at subshield	1	30-45 (38±3.86)	50-80 (60±8.72)	221-247 (231)

Name of species	Profile	Colour	No. of band	Length (mm)	Diameter (μ)	Scale count/mm of hair length
Prionodon pardicolor	Spatulate Straight Shielded Band may or may not present	Claret brown, broad buff band at subshield, if present	1 or absent	10-25 (18±6.82)	50-70 (63±5.21)	176-221 (205)
Arctictis binturong	Rod like, little wavy, non banded	Black	Nil	40-70 (55± 11.21)	100-130 (110±8.76)	204-236 (218)
Arctogalidia trivirgata	Spatulate Straight or little wavy Shielded non-Banded	Burnt sienna, lighter at basal	Nil	60-85 (76±8.2)	40-60 (52±8.08)	287-356 (331)
Viverra zibetha	Spatulate Straight Shielded Band may or may not present	Claret brown, narrow buff band not more than 4 mm at sub shield, if present	1, if present	30-40 (33±5.8)	80-110 (95±9.36)	217-315 (234)
Viverra civettina	Spatulate Straight Shielded Band may or may not present	Dark bay, broad buff band at sub-shield, if present	1, if present	30-40 (34±3.42)	80-110 (100±6.18)	212-267 (240)
Paradoxurus jerdoni	Spatulate Straight Shielded non-Banded	Claret brown, lighter at basal	Nil	20-40 (30±8.81)	70-110 (90±12)	396-423 (400)
Paradoxurus hermaphroditus	Spatulate Straight Shielded Non-banded	Dark bay, either in whole or at apical, basal lighter	Nil	20-40 (31±7.25	70-110 (92±10.76)	291-347 (325)
VII. Family : Mustelidae						
Martes foina	Spatulate Straight Shielded	From shield to tip Vandyke brown and basal light	Nil	31-36 (33.4± 1.5)	45-55 (53±1.25)	298-379 (335)
Martes flavigula	Spatulate Straight Shielded	Shield brunt umber with lighter basal	Nil	27-30 (28.6± 1.2)	40-50 (45.5±3.6)	274-363 (319)

Name of species	Profile	Colour	No. of band	Length (mm)	Diameter (μ)	Scale count/mm of hair length
Melogale personata	Spatulate Straight Shielded	Clove brown from shield to upper part and basal drab	Nil	15-20 (18.4± 1.31)	100-120 (110±4.51)	287-371 (343)
Melogale moschata	Spatulate Straight Shielded	Vandyke brown with paler basal	Nil	25-29 (27.51± 1.35)	80-100 (90±5.24)	284-397 (336)
Mellivora capensis	Spatulate Straight Shielded	From shield to tip slaty grey with lighter basal	Nil	16-23 (18.02± 1.32)	100-120 (110.78±4.6)	287-372 (334)
Mustela sibirica	Spatulate Straight Shielded	From shield to tip brunt umber with lighter basal	Nil	15-18 (16.23± 0.74)	50-70 (55.02±1.35)	242-358 (296)
Mustela erminea	Spatulate Straight Shielded	Mummy brown	Nil	9-12 (10.64± 1.2)	50-70 (58.0±7.12)	B & Ssh: 291-357 (325) S: 278-367 (336)
Mustela kathia	Spatulate Straight Shielded	Bistre	Nil	20-24 (22.16± 1.78)	50-70 (55.15±2.45)	B & Ssh: 285-364 (343) S: 264-342 (328)
Mustela altaica	Spatulate Straight Shielded	Bistre	Nil	12-15 (13.41± 1.07)	50-70 (56.23±3.21)	B & Ssh: 252-369 (351) S: 272-332 (318)
Lutra lutra	Spatulate Straight Shielded	Shield and upper part Prout's Brown with lighter basal	Nil	18-26 (22.41± 3.39)	25-32 (28±2.45)	B: 364-432 (396) Ssh: 284-386 (324) S: 176-285 (257)
Lutrogale perspicillata	Spatulate Straight Shielded	From shield to tip Prout's brown with lighter basal	Nil	12-14 (13.19± 0.62)	30-40 (32.72±2.32)	B & Ssh: 276-373 (326) S: 198-285 (242)
Arctonyx collaris	Spatulate Straight Shielded	Shield and upper part clove brown and rest yellow ochre	Nil	26-48 (38.88± 5.82)	100-115 (107.25±2.26)	328-376 (348)
Amblonyx cinereus	Spatulate Straight Shielded	From shield to tip brunt umber with lighter basal	Nil	14-20 (17±1.55)	25-30 (27±1.4)	B: 269-364 (337) S & Ssh: 190-262 (248)

Table II : Surface structure of dorsal guard hairs of Indian Species of the Order Carnivora (Mean and SD is given in parenthesis)

Abbreviations Used : A : Apical, B : Basal, M : Middle, S : Shield; SS : Side to side cuticular scale length; PD: Proximodistal scale length

Name of Species	SS (μ)	PD (μ)	Scale margin	Scale margin distance	Scale type	Scale pattern
I. Family : Felidae						
Panthera tigris	12-30 (18±6)	4-9 (7±2)	Crenate	Intermediate	Imbricate-flattened	Irregular wave
Panthera leo	19-48 (32±8)	7-10 (9±1)	Smooth with little waves	Intermediate	Imbricate-flattened	Irregular waved mosaic
Panthera pardus	20-40 (33±5)	7-14 (10±3)	Irregularly waved with few notches	Intermediate	Imbricate-flattened	Irregular waved mosaic
Uncia uncia	21-30 (26±3)	9-22 (14±4)	Irregularly rippled	Distant	Imbricate-Crenate	Irregular wave
Acinonyx jubatus venaticus	7.5-21.87 (14.81±4.31)	3.12-9.39 (5.25±2.24)	Irregularly rippled	Intermediate	Imbricate, Crenate	Irregular wave
Pardofelis marmorata	B: 7-17 (11.8±1.08) Ssh: 12.5-17 (9.5±1.62) S: 8-10 (9.5±0.17)	B: 5-10 (5.8±0.49) Ssh: 7-12 (9.8±1.79) S: 19-25 (22±1.91)	Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate flattened S: Accuminate	B & Ssh: Regular wave S: Diamond petal or broad petal
Prionailurus rubiginosus	B: 8-16 (122±3.1) Ssh: 10.5-28 (18.7±4.2) S: 19-35 (29.0±1.9)	B: 4-7 (4.8±0.23) Ssh: 4-10 (6.1±1.4) S: 8-10.5 (9.125±0.6)	B & Ssh: Rippled S: Smooth	B: Close Ssh: Intermediate S: Distant	B & Ssh: Imbricate-crenate S: Imbricate-flattened	B&Ssh: Irregular wave S: Mosaic
Prionailurus bengalensis	11-16 (12.4±0.15)	3-5 (4.2±0.6)	Crenate	Close	Imbricate-crenate	Irregular wave
Prionailurus viverrinus	20-30 (24.0±2.8)	3-7 (4.8±1)	Crenate	Close	Imbricate-crenate	Irregular wave
Otocolobus manul	34-47 (39.2±1.9)	6-11 (7.2±0.6)	Smooth	Intermediate	Imbricate-flattened, apical-elongate	Regular mosaic
Felis silvestris	20-34 (26±4.937)	17-24 (19.85± 1.816)	Smooth	Distant	Diamond petal or imbricate-ovate	Regular mosaic

Name of Species	SS (μ)	PD (μ)	Scale margin	Scale margin distance	Scale type	Scale pattern
Felis chaus	B: 21-44 (31.6±6.68) Ssh: 27-50 (39.7±7.3) S: 24-35 (28±3.5)	B: 3-11.5 (6.6±2.54) Ssh: 10-15.5 (10.8±1.9) S: 8-14 (11.45±2.45)	B: Crenate S & Ssh: Smooth	Intermediate	B: Imbricate-crenate S & Ssh: Imbricate-flattened	B: Irregular wave S & Ssh: Mosaic
Catopuma temminckii	26-31 (29±1.89)	6-10 (7.6±1.03)	Smooth	Intermediate	Imbricate-flattened	Regular mosaic
Caracal caracal	16-28 (23.9±1.29)	4-10 (5.1±0.6)	Crenate	Close	Imbricate-crenate	Irregular wave mosaic
Lynx lynx	14-42 (30.4±4.1)	5-8 (6.4±1.01)	Smooth	Intermediate	Imbricate-flattened	Regular wave
Neofelis nebulosa	B: 23-49 (33±9.1) Ssh: 12-23 (16.75±2.8) S: 11-36 (20.35±6.81)	B: 2.5-8.0 (7.65±2.75) Ssh: 4.5-7 (6.1±0.94) S: 7.0-11.5 (9.55±1.44)	B & Ssh: Crenate S: Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-crenate, S: Imbricate-flattened	B & Ssh: Irregular wave, S: Mosaic
II. Family : Ursidae						
Ursus arctos	20-40 (34±4.95)	10-30 (18±5.44)	Smooth	Intermediate	Imbricate-smooth	B & Ssh: Irregular wave S: Irregular mosaic
Ursus thibetanus	30-50 (40±6.32)	2-10 (7±1.58)	Crenate	Close	Imbricate Crenate	B & Ssh: Irregular wave S: Irregular mosaic
Helarctos malayanus	30-70 (47±13.46)	10-20 (17±2.58)	Crenate	Intermediate	Imbricate Crenate	B: Irregular mosaic S & Ssh: Regular wave
Melursus ursinus	30-60 (45±10.25)	3-10 (7±2.58)	Smooth	Intermediate	Imbricate	B & Ssh: Regular wave S: Regular mosaic
Ailurus fulgens	3.1-4.4 (4±0.23)	10-14.4 (13.12±0.36)	Smooth	Distant	Petaloid	Diamond petal

Name of Species	SS (µ)	PD (µ)	Scale margin	Scale margin distance	Scale type	Scale pattern
III. Family : Hyaenidae						
Hyaena hyaena	57.25-71.5 (64.26±5.04)	1.8-13.9 (10.75±2.05)	Crenate	Intermediate	Imbricate crenate	Irregular wave
IV. Family : Canidae						
Canis aureus	33-43 (37.5±3.04)	8-10 (8.45±1.31)	Crenate	Intermediate	Imbricate Crenate	Irregular wave
Canis lupus	10-33 (26.7±7.74)	8-16.5 (10.5±2.34)	Smooth with number of notches	Intermediate	Imbricate Crenate	Irregular wave
Vulpes vulpes	B: 8.75-12.5 (11.03±1.35) Ssh: 9.4-0.15 (12.12±1.55) S: 12.5-16.25 (14.5±1.27)	B: 3.1-6.25 (4.62±1.02) Ssh: 3.7-9.4 (5.13±1.39) S: 3.75-7.5 (5.68±0.85)	B & M: Crenate A: Smooth	B & M: Intermediate A: Distant	B & M: Imbricate-Crenate A: Imbricate-elongate or coronal-dentate	B: Irregular wave M: Irregular mosaic A: Pectinate or mosaic
Vulpes bengalensis	10-13 (11.6±1.39)	24-32 (26.2±2.2)	Almost smooth with few notches	B & M: Intermediate A: Distant	B & M: Imbricate-flattened A: Coronal-dentate	B & M: Irregular wave Mosaic A: Diamond petal
Cuon alpinus	M & B: 32-55 (43±3.7) A: 7-10 (7.8±1.2)	M & B: 7-18 (12.4±3.8) A: 39-49 (42.8±2.77)	B & M: Crenate A: Almost smooth	B & M: Intermediate A: Distant	B & M: Imbricate Crenate A: Coronal dentate	B & M: Irregular wave A: Pectinate
V. Family : Herpestidae						
Herpestes edwardsi	20-40 (30±4.58)	2-7 (5±0.91)	Crenate	Near	Imbricate-crenate	Irregular wave
Herpestes javanicus	10-20 (16±3.06)	7-10 (8.31±0.08)	Smooth	Near	Imbricate-smooth	Flattened irregular mosaic
Herpestes smithi	20-50 (30±5.01)	3-10 (7±2.89)	Crenate	Near	Imbricate-crenate	Irregular wave
Herpestes palustris	10-20 (16±2.02)	4-10 (7.01±1.16)	Smooth with few notches	Near	Imbricate-crenate	Irregular wave
Herpestes urva	13-30 (20±4.1)	8-13 (11±1.2)	Crenate	Intermediate	Imbricate-crenate	Irregular wave

Name of Species	SS (μ)	PD (μ)	Scale margin	Scale margin distance	Scale type	Scale pattern
VI. Family : Viverridae						
Viverricula indica	S: 20-25 (22±1.6)	S: 43-60 (53.5±4.66)	B & Ssh: Crenate S: Smooth	B & Ssh: Close S: Distant	B & Ssh: Imbricate-crenate S: Accuminate	Transitional B & Ssh: Irregular wave S: Regular petal
Paguma larvata	42-57 (47.7±3.94)	13-21 (16.5±3.46)	Crenate	Close	Imbricate-crenate	Irregular wave
Prionodon pardicolor	S: 15-22 (18.5±2.52)	S: 56-71 (62.5±5.21)	Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-flattened S: Accuminate	Transitional B & Ssh: Regular wave S: Narrow diamond petal
Arctictis binturong	47-66 (56.5±6)	10-19 (15±2.96)	Crenate	Intermediate	Imbricate-flattened	Irregular wave
Arctogalidia trivirgata	50-80 (68.6±8.96)	11-19 (13.8±2.35)	Crenate	Intermediate	Imbricate-Crenate	Irregular wave
Viverra zibetha	32-49 (37±2.04)	33-45 (39±3.52)	Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-flattened S: Imbricate-ovate	Transitional S: Regular mosaic B & Ssh: Regular wave
Viverra civettina	69-98 (80.75±9.21)	8-15 (11.25±1.85)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Paradoxurus jerdoni	37-51 (45.25±4.8)	9-14 (11.25±1.16)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Paradoxurus hermaphroditus	28-39 (35.5±3.1)	6-11 (8.75±2)	Crenate	Close	Imbricate-crenate	Irregular wave
VII. Family : Mustelidae						
Martes foina	37-52 (44.4±4.86)	12-17 (13.90±1.64)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Martes flavigula	25-41 (32.36±3.72)	8-14 (11.71±2.02)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Melogale personata	40-55 (46.06±3.48)	12-18 (15.34±1.82)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Melogale moschata	45-60 (48.52±2.67)	15-20 (17.21±1.59)	Crenate	Intermediate	Imbricate-crenate	Irregular wave

Name of Species	SS (µ)	PD (µ)	Scale margin	Scale margin distance	Scale type	Scale pattern
Mellivora capensis	55-70 (62.30±4.87)	12-18 (15.25±2.03)	Crenate	Intermediate	Imbricate crenate	Irregular wave
Mustela sibirica	B & Ssh: 50-77 (71.30±4.31) S: 15-24 (18.21±2.63)	B & Ssh: 33-60 (46.44±8.52) S: 75-104 (95.37±8.58)	Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-flattened S: Accuminate	B & Ssh: Regular wave S: Diamond Petal
Mustela erminea	B & Ssh: 54-82 (73.45±3.80) S: 17-28 (21.7±3.1)	B & Ssh: 30-58 (42.32±7.23) S: 72-96 (91.3±2.58)	B & Ssh: Crenate S: Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-crenate S: Accuminate	B & Ssh: Irregular wave S: Diamond Petal
Mustela kathia	11-16 (13.5±1.25)	19-25 (21.45±1.70)	Smooth	Distant	Accuminate	Diamond petal
Mustela altaica	12-23 (14.8±2.1)	20-28 (20.26±1.3)	Smooth	Distant	Accuminate	Diamond Petal
Lutra lutra	B: 35-91 (58.62±12.21) Ssh: 19-52 (31.8±10.5) S: 12-15 (13.40±1.01)	B: 20-36 (28.73±4.26) Ssh: 18-27 (21.71±2.25) S: 10-16 (11.22±1.15)	B & Ssh: Rippled S: Smooth	B & Ssh.: Near B: Distant	B & Ssh: Imbricate-crenate S: Accuminate	B & Ssh: Irregular wave S: Diamond petal
Lutrogale perspicillata	B & Ssh: 35-44 (39.41±2.88) S: 14-28 (16.80±1.83)	B & Ssh: 18-39 (27.28±5.62) S: 11-18 (14.69±1.2)	B & Ssh: Crenate S: Smooth	B & Ssh: Intermediate S: Distant	B & Ssh: Imbricate-crenate S: Accuminate	B & Ssh: Irregular wave S: Diamond petal
Arctonyx collaris	36.74 (60.70 ±12.57)	17-23 (20.10±2.18)	Crenate	Intermediate	Imbricate-crenate	Irregular wave
Amblonyx cinereus	B: 45-80 (65.32±11.56) S & Ssh: 18-42 (24.12±4.68)	B: 13-22 (16.56±2.25) S & Ssh: 12-18 (15.16±2.14)	B: Crenate S & Ssh: Smooth	B: Intermediate S & Ssh: Distant	B: Imbricate-Crenate S & Ssh: Accuminate	B: Irregular wave S & Ssh: Diamond Petal

Table III : Medulla, Medullary Index and Cross Section of Dorsal Guard Hairs of the Indian Species of the Order Carnivora

Name of Species	Medullary Configuration	Medullary Index	Cross Section
Family : Felidae			
Panthera tigris	Simple unbroken amorphous	0.541-0.563 (0.551±0.006)	Circular
Panthera leo	Simple unbroken amorphous	0.550-0.557 (0.553±0.002)	Circular
Panthera pardus	Unbroken vacuolated	0.657-0.668 (0.663±0.004)	Circular
Uncia uncia	Unbroken vacuolated	0.659-0.672 (0.665±0.005)	Circular
Acinonyx jubatus venaticus	Simple unbroken amorphous	0.62-0.66 (0.635±0.001)	Circular
Pardofelis marmorata	Uniserial ladder	0.54-0.60 (0.577±0.004)	Almost Circular
Prionailurus rubiginosus	Unbroken cellular	0.777-0.779 (0.778±0.001)	Ovate
Prionailurus bengalensis	Unbroken cellular	0.78-0.8 (0.79±0.07)	Ovate
Prionailurus viverrinus	Unbroken cellular	0.74-0.77 (0.75±0.009)	Ovate
Otocolobus manul	Unbroken amorphous	0.60-0.63 (0.62±0.006)	Oblong
Felis silvestris	Uniserial ladder	0.75-0.76 (0.755±0.00025)	Circular
Felis chaus	Unbroken vacuolated	0.684-0.71 (0.699±0.004)	Ovate
Catopuma temminckii	Unbroken cellular	0.59-0.60 (0.595±0.0026)	Almost Circular
Caracal caracal	Unbroken amorphous	0.80-0.82 (0.805±0.001)	Ovate
Lynx lynx	Unbroken cellular	0.774-0.848 (0.806±0.0304)	Ovate
Neofelis nebulosa	Unbroken vacuolated	0.608-0.63 (0.62±0.008)	Ovate
Family : Ursidae			
Ursus arctos	Unbroken cellular	0.32-0.34 (0.33±0.012)	Oval
Ursus thibetanus	Unbroken vacuolated	0.29-0.32 (0.31±0.01)	Circular
Helarctos malayanus	Simple unbroken amorphous	0.86-0.89 (0.87±0.001)	Circular
Melursus ursinus	Simple unbroken amorphous	0.91-0.92 (0.91±0.008)	Oblong
Ailurus fulgens	Unbroken cellular	0.61-0.649 (0.63±0.011)	Circular
Family : Hyaenidae			
Hyaena hyaena	Simple unbroken cellular	0.56-0.59 (0.57±0.002)	Almost Circular
Family : Canidae			
Canis aureus	Vacuolated	0.66-0.68 (0.67±0.02)	Circular
Canis lupus	Vacuolated	0.53-0.58 (0.55±0.018)	Circular
Vulpes vulpes	Vacuolated	0.72-0.73 (0.722±0.004)	Circular
Vulpes bengalensis	Vacuolated	0.80-0.83 (0.81±0.012)	Circular
Cuon alpinus	Vacuolated	0.58-0.60 (0.59±0.02)	Circular
Family : Herpestidae			
Herpestes edwardsi	Unbroken with cortical intrusion	0.81-0.83 (0.82±0.003)	Oblong

Name of Species	Medullary Configuration	Medullary Index	Cross Section
Herpestes javanicus	Unbroken with cortical intrusion	0.88-0.90 (0.885±0.0067)	Ovate
Herpestes smithi	Unbroken cellular	0.6-0.62 (0.617±0.008)	Ovate
Herpestes palustris	Narrow aeriform lattice	0.75-0.76 (0.755±0.004)	Ovate
Herpestes urva	Unbroken vacuolated	0.49-0.52 (0.506±0.01)	Ovate
Family : Viverridae			
Viverricula indica	Unbroken vacuolated	0.76-0.78 (0.769±0.02)	Ovate
Paguma larvata	Unbroken vacuolated	0.81-0.83 (0.826±0.01)	Ovate
Prionodon pardicolor	Unbroken vacuolated	0.62-0.66 (0.64±0.08)	Circular
Arctictis binturong	Simple	0.926-0.931 (0.93±0.001)	Reniform
Arctogalidia trivirgata	Unbroken vacuolated	0.60-0.69 (0.66±0.02)	Circular
Viverra zibetha	Unbroken vacuolated	0.88-0.896 (0.89±0.01)	Ovate
Viverra civettina	Unbroken vacuolated	0.60-0.65 (0.62±0.09)	Ovate
Paradoxurus jerdoni	Unbroken vacuolated	0.60-0.68 (0.64±0.03)	Circular
Paradoxurus hermaphroditus	Unbroken vacuolated	0.70-0.78 (0.72±0.02)	Ovate
Family : Mustelidae			
Martes foina	Narrow medulla lattice	0.77-0.81 (0.79±0.011)	Oblong
Martes flavigula	Narrow medulla lattice	0.69-0.71 (0.70±0.01)	Oblong
Melogale personata	Unbroken lattice	0.72-0.77 (0.75±0.02)	Oblong
Melogale moschata	Unbroken lattice	0.72-0.77 (0.75±0.013)	Oblong
Mellivora capensis	Unbroken amorphous	0.58-0.61 (0.59±0.04)	Reniform / concavo-convex
Mustela sibirica	Unbroken amorphous	0.60-0.63 (0.61±0.01)	Oblong
Mustela erminea	Unbroken cellular	0.48-0.52 (0.5±0.017)	Oval or Oblong
Mustela kathia	Narrow aeriform lattice	0.64-0.66 (0.65±0.007)	Oblong
Mustela altaica	Wide aeriform lattice	0.50-0.53 (0.52±0.06)	Oval
Lutra lutra	Unbroken cellular	0.62-0.66 (0.64±0.002)	Circular
Lutrogale perspicillata	Unbroken cellular	0.60-0.64 (0.62±0.003)	Oblong
Arctonyx collaris	Unbroken amorphous	0.48-0.52 (0.50±0.002)	Oval or Oblong
Amblonyx cinereus	Unbroken cellular	0.71-0.73 (0.72±0.007)	Oval or Oblong

SUMMARY

Among the 60 Indian carnivore species, hair characteristics of 54 species belonging to 7 families and 36 genera are provided in this book. Diversity in both cuticular and medullar structure is noticed among the order Carnivora. With few exceptions, cuticular structure is usually wavy in basal and subshield region and the same is petaloid at shield or distal region of hair. In many species the cuticular structure is uniform throughout the shaft. The medullary configuration is also differs from species to species with the only exception in family Canidae where the medulla is 'vacuolated' in all the five species. The medullary configuration is 'unbroken vacuolated' in the family Viverridae with only one exception in *Arctictis binturong* where it is 'simple'. The cross sectional structure is usually circular, oblong, ovate or oval in the order Carnivora with exception in only two species *Arctictis binturong* and *Mellivora capensis* where the same is reniform. In a nutshell, there is considerable overlapping in hair characteristics among the species of the order Carnivora. Thus, it is not possible to identify species from one or two characters but the same could definitely be possible with a group of characters.

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